***CHAPTER 10***

**SOME LESSONS FROM CAPITAL MARKET HISTORY**

# Answers to Concepts Review and Critical Thinking Questions

**1.** They all wish they had! Since they didn’t, it must have been the case that the stellar performance was not foreseeable, at least not by most.

**2.** As in the previous question, it’s easy to see after the fact that the investment was terrible, but it probably wasn’t so easy ahead of time.

**3.** No, stocks are riskier. Some investors are highly risk averse, and the extra possible return doesn’t attract them relative to the extra risk.

**4.** Unlike gambling, the stock market is a positive sum game; everybody can win. Also, speculators provide liquidity to markets and thus help to promote efficiency.

**5.** T-bill rates were highest in the early eighties. This was during a period of high inflation and is consistent with the Fisher effect.

**6.** Before the fact, for most assets, the risk premium will be positive; investors demand compensation over and above the risk-free return to invest their money in the risky asset. After the fact, the observed risk premium can be negative if the asset’s nominal return is unexpectedly low, the risk-free return is unexpectedly high, or if some combination of these two events occurs.

**7.** Yes, the stock prices are currently the same. Below is a diagram that depicts the stocks’ price movements. Two years ago, each stock had the same price, P0. Over the first year, General Materials’ stock price increased by 10 percent, or (1.1) × P0. Standard Fixtures’ stock price declined by 10 percent, or (.9) × P0. Over the second year, General Materials’ stock price decreased by 10 percent, or (.9)(1.1) × P0, while Standard Fixtures’ stock price increased by 10 percent, or (1.1)(.9) × P0. Today, each of the stocks is worth 99 percent of its original value.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  |  |  |  |
|  | 2 years ago | 1 year ago | Today |  |
| General Materials | P0 | (1.1)P0 | (1.1)(.9)P0 | = (.99)P0 |
| Standard Fixtures | P0 | (.9)P0 | (.9)(1.1)P­0 | = (.99)P0 |

**8.** The stock prices are not the same. The return quoted for each stock is the arithmetic return, not the geometric return. The geometric return tells you the wealth increase from the beginning of the period to the end of the period, assuming the asset had the same return each year. As such, it is a better measure of ending wealth. To see this, assuming each stock had a beginning price of $100 per share, the ending price for each stock would be:

 Lake Minerals ending price = $100(1.10)(1.10) = $121.00

 Small Town Furniture ending price = $100(1.25)(.95) = $118.75

 Whenever there is any variance in returns, the asset with the larger variance will always have the greater difference between the arithmetic and geometric return.

**9.** To calculate an arithmetic return, you sum the returns and divide by the number of returns. As such, arithmetic returns do not account for the effects of compounding. Geometric returns do account for the effects of compounding. As an investor, the more important return of an asset is the geometric return.

**10.** Risk premiums are about the same whether or not we account for inflation. The reason is that risk premiums are the difference between two returns, so inflation essentially nets out. Returns, risk premiums, and volatility would all be lower than we estimated because aftertax returns are smaller than pretax returns.

**Solutions to Questions and Problems**

*NOTE: All end of chapter problems were solved using a spreadsheet. Many problems require multiple steps. Due to space and readability constraints, when these intermediate steps are included in this solutions manual, rounding may appear to have occurred. However, the final answer for each problem is found without rounding during any step in the problem.*

 *Basic*

**1.** The return of any asset is the increase in price, plus any dividends or cash flows, all divided by the initial price. The return of this stock is:

 *R* = [($84 – 76) + 1.95]/$76

 *R* = .1309, or 13.09%

**2.** The dividend yield is the dividend divided by the price at the beginning of the period, so:

 Dividend yield = $1.95/$76

 Dividend yield = .0257, or 2.57%

 And the capital gains yield is the increase in price divided by the initial price, so:

 Capital gains yield = ($84 – 76)/$76

 Capital gains yield = .1053, or 10.53%

**3.** Using the equation for total return, we find:

 *R* = [($68 – 76) + 1.95]/$76

 *R* = –.0796, or –7.96%

 And the dividend yield and capital gains yield are:

 Dividend yield = $1.95/$76

 Dividend yield = .0257, or 2.57%

 Capital gains yield = ($68 – 76)/$76

 Capital gains yield = –.1053, or –10.53%

 Here’s a question for you: Can the dividend yield ever be negative? No, that would mean you were paying the company for the privilege of owning the stock. It has happened on bonds.

**4.** The total dollar return is the change in price plus the coupon payment, so:

 Total dollar return = $1,052 – 1,010 + 49

 Total dollar return = $91

 The total nominal percentage return of the bond is:

 *R* = [($1,052 – 1,010) + 49]/$1,010

 *R* = .0901, or 9.01%

Notice here that we could have used the total dollar return of $91 in the numerator of this equation.

 Using the Fisher equation, the real return was:

 (1 + *R*) = (1 + *r*)(1 + *h*)

 *r* = (1.0901/1.030) – 1

 *r* = .0583, or 5.83%

**5.** The nominal return is the stated return, which is 12.1 percent. Using the Fisher equation, the real return was:

 (1 + *R*) = (1 + *r*)(1 + *h*)

 *r* = (1.121)/(1.03) – 1

 *r* = .0883, or 8.83%

**6.** Using the Fisher equation, the real returns for government and corporate bonds were:

 (1 + *R*) = (1 + *r*)(1 + *h*)

 *r*G = 1.060/1.030 – 1

 *r*G = .0291, or 2.91%

 *r*C = 1.064/1.030 – 1

 *r*C = .0330, or 3.30%

**7.** The average return is the sum of the returns, divided by the number of returns. The average return for each stock was:



 

 We calculate the variance of each stock as:

 

 The standard deviation is the square root of the variance, so the standard deviation of each stock is:

 σ*X* = .041331/2

 σ*X* = .2033, or 20.33%

 σ*Y* = .074121/2

 σ*Y* = .2722, or 27.22%

**8.** We will calculate the sum of the returns for each asset and the observed risk premium first. Doing so, we get:

 Year Large co. stock return T-bill return Risk premium

 1973 –14.69% 7.29% −21.98%

 1974 –26.47 7.99 –34.46

 1975 37.23 5.87 31.36

 1976 23.93 5.07 18.86

 1977 –7.16 5.45 –12.61

 1978 6.57 7.64 –1.07

 19.41% 39.31% –19.90%

 *a*. The average return for large company stocks over this period was:

 Large company stock average return = 19.41%/6

 Large company stock average return = 3.24%

 And the average return for T-bills over this period was:

1. T-bills average return = 39.31%/6
2. T-bills average return = 6.55%

 *b*. Using the equation for variance, we find the variance for large company stocks over this period was:

 Variance = 1/5[(–.1469 – .0324)2 + (–.2647 – .0324)2 + (.3723 – .0324)2 + (.2393 – .0324)2 +

 (–.0716 – .0324)2 + (.0657 – .0324)2]

 Variance = .058136

 And the standard deviation for large company stocks over this period was:

 Standard deviation = (.058136)1/2

 Standard deviation = .2411, or 24.11%

 Using the equation for variance, we find the variance for T-bills over this period was:

 Variance = 1/5[(.0729 – .0655)2 + (.0799 – .0655)2 + (.0587 – .0655)2 + (.0507 – .0655)2 +

 (.0545 – .0655)2 + (.0764 – .0655)2]

 Variance = .000153

 And the standard deviation for T-bills over this period was:

 Standard deviation = (.000153)1/2

 Standard deviation = .0124, or 1.24%

 *c*. The average observed risk premium over this period was:

 Average observed risk premium = –19.90%/6

 Average observed risk premium = –3.32%

 The variance of the observed risk premium was:

 Variance = 1/5[(–.2198 – (–.0332))2 + (–.3446 – (–.0332))2 + (.3136 – (–.0332))2 +

 (.1886 – (–.0332))2 + (–.1261 – (–.0332))2 + (–.0107 – (–.0332))2]

 Variance = .062078

 And the standard deviation of the observed risk premium was:

 Standard deviation = (.062078)1/2

 Standard deviation = .2492, or 24.92%

**9.** *a*. To find the average return, we sum all the returns and divide by the number of returns, so:

 Arithmetic average return = (.19 + .24 + .11 – .09 + .13)/5

 Arithmetic average return = .1160, or 11.60%

 *b*. Using the equation to calculate variance, we find:

 Variance = 1/4[(.19 – .116)2 + (.24 – .116)2 + (.11 – .116)2 + (–.09 – .116)2 +

 (.13 – .116)2]

 Variance = .01588

 So, the standard deviation is:

 Standard deviation = .015881/2

 Standard deviation = .1260, or 12.60%

**10.** *a*. To calculate the average real return, we can use the average return of the asset and the average inflation rate in the Fisher equation. Doing so, we find:

 (1 + *R*) = (1 + *r*)(1 + *h*)

  = (1.116/1.036) – 1

  = .0772, or 7.72%

 *b*. The average risk premium is the average return of the asset, minus the average real risk-free rate, so, the average risk premium for this asset would be:

 – 

 = .1160 – .0410

 = .0750, or 7.50%

**11.** We can find the average real risk-free rate using the Fisher equation. The average real risk-free rate was:

 (1 + *R*) = (1 + *r*)(1 + *h*)

 = (1.041/1.036) – 1

 = .0048, or .48%

 And to calculate the average real risk premium, we can subtract the average risk-free rate from the average real return. So, the average real risk premium was:

  – 

 = .0772 – .0048

 = .0724, or 7.24%

**12.** Applying the five-year holding-period return formula to calculate the total return of the stock over the five-year period, we find:

5-year holding-period return = [(1 + *R*1)(1 + *R*2)(1 + *R*3)(1 + *R*4)(1 + *R*5)] – 1

 5-year holding-period return = [(1 + .1279)(1 + .0921)(1 + .1468)(1 + .2183)(1 – .1034)] – 1

 5-year holding-period return = .5430, or 54.30%

**13.**  To find the return on the zero coupon bond, we first need to find the price of the bond today. Since one year has elapsed, the bond now has 20 years to maturity. Using semiannual compounding, the price today is:

 P1 = $1,000/1.03240

 P1 = $283.67

 There are no intermediate cash flows on a zero coupon bond, so the return is the capital gain, or:

 *R* = ($283.67 – 273.82)/$273.82

 *R* = .0360, or 3.60%

**14.**  The return of any asset is the increase in price, plus any dividends or cash flows, all divided by the initial price. This preferred stock paid a dividend of $3.10, so the return for the year was:

 *R* = ($97.18 – 94.82 + 3.10)/$94.82

 *R* = .0576, or 5.76%

**15.** The return of any asset is the increase in price, plus any dividends or cash flows, all divided by the initial price. This stock paid no dividend, so the return was:

 *R* = ($91.45 – 82.18)/$82.18

 *R* = .1128, or 11.28%

 This is the return for three months, so the APR is:

 APR = 4(11.28%)

 APR = 45.12%

 And the EAR is:

 EAR = (1 + .1128)4 – 1

 EAR = .5335, or 53.35%

**16.** To find the real return each year, we will use the Fisher equation, which is:

 1 + *R* = (1 + *r*)(1 + *h*)

 Using this relationship for each year, we find:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  | T-bills | Inflation | Real Return |
|  | 1926 |  .0330  |  –.0112 |  .0447  |
|  | 1927 |  .0315  |  –.0226 |  .0554  |
|  | 1928 |  .0405  |  –.0116 |  .0527  |
|  | 1929 |  .0447  |  .0058  |  .0387  |
|  | 1930 |  .0227  |  –.0640 |  .0926  |
|  | 1931 |  .0115  |  –.0932 |  .1155  |
|  | 1932 |  .0088  |  –.1027 |  .1243  |

 So, the average real return was:

 Average = (.0447 + .0554 + .0527 + .0387 + .0926 + .1155 + .1243)/7

 Average = .0748, or 7.48%

Notice the real return was higher than the nominal return during this period because of deflation, or negative inflation.

**17.** Looking at the long-term corporate bond return history in Table 10.2, we see that the mean return was 6.4 percent, with a standard deviation of 8.3 percent. The range of returns you would expect to see 68 percent of the time is the mean plus or minus 1 standard deviation, or:

 *R*∈ μ ± 1σ = 6.4% ± 8.3% = –1.90% to 14.70%

 The range of returns you would expect to see 95 percent of the time is the mean plus or minus 2 standard deviations, or:

 *R*∈ μ ± 2σ = 6.4% ± 2(8.3%) = –10.20% to 23.00%

**18.**  Looking at the large-company stock return history in Table 10.2, we see that the mean return was 12.1 percent, with a standard deviation of 19.8 percent. The range of returns you would expect to see 68 percent of the time is the mean plus or minus 1 standard deviation, or:

 *R*∈ μ ± 1σ = 12.1% ± 19.8% = –7.70% to 31.90%

 The range of returns you would expect to see 95 percent of the time is the mean plus or minus 2 standard deviations, or:

 *R*∈ μ ± 2σ = 12.1% ± 2(19.8%) = –27.50% to 51.70%

 *Intermediate*

**19.** Here we know the average stock return, and four of the five returns used to compute the average return. We can work the average return equation backward to find the missing return. The average return is calculated as:

 5(.101) = .17 – .19 + .09 + .34 + *R*

 *R* = .095, or 9.5%

 The missing return has to be 9.5 percent. Now we can use the equation for the variance to find:

 Variance = 1/4[(.17 – .101)2 + (–.19 – .101)2 + (.09 – .101)2 + (.34 – .101)2 + (.095 – .101)2]

 Variance = .03668

 And the standard deviation is:

 Standard deviation = .036681/2

 Standard deviation = .1915, or 19.15%

**20.** The arithmetic average return is the sum of the known returns divided by the number of returns, so:

 Arithmetic average return = (.23 + .11 + .37 – .03 + .22 – .17)/6

 Arithmetic average return = .1217, or 12.17%

 Using the equation for the geometric return, we find:

 Geometric average return = [(1 + *R*1) × (1 + *R*2) × … × (1 + *RT*)]1/*T* – 1

 Geometric average return =[(1 + .23)(1 + .11)(1 + .37)(1 – .03)(1 + .22)(1 – .17)]1/6 – 1

 Geometric average return = .1067, or 10.67%

 Remember, the geometric average return will always be less than the arithmetic average return if the returns have any variation.

**21.** To calculate the arithmetic and geometric average returns, we must first calculate the return for each year. The return for each year is:

 *R*1 = ($68.13 – 64.12 + 1.15)/$64.12 = .0805, or 8.05%

 *R*2 = ($61.23 – 68.13 + 1.25)/$68.13 = –.0829, or –8.29%

 *R*3 = ($74.27 – 61.23 + 1.36)/$61.23 = .2352, or 23.52%

 *R*4 = ($77.38 – 74.27 + 1.47)/$74.27 = .0617, or 6.17%

 *R*5 = ($86.19 – 77.38 + 1.60)/$77.38 = .1345, or 13.45%

 The arithmetic average return was:

 *R*A = (.0805 – .0829 + .2352 + .0617 + .1345)/5

 *R*A = .0858, or 8.58%

 And the geometric average return was:

 *R*G = [(1 + .0805)(1 – .0829)(1 + .2352)(1 + .0617)(1 + .1345)]1/5 – 1

 *R*G = .0807, or 8.07%

**22.** To find the real return we need to use the Fisher equation. Re-writing the Fisher equation to solve for the real return, we get:

 *r* = [(1 + *R*)/(1 + *h*)] – 1

 So, the real return each year was:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Year | T-bill return | Inflation | Real return |
|  | 1973 |  .0729  |  .0871  |  –.0131 |
|  | 1974 |  .0799  |  .1234  |  –.0387 |
|  | 1975 |  .0587  |  .0694  |  –.0100 |
|  | 1976 |  .0507  |  .0486  |  .0020  |
|  | 1977 |  .0545  |  .0670  |  –.0117 |
|  | 1978 |  .0764  |  .0902  |  –.0127 |
|  | 1979 |  .1056  |  .1329  |  –.0241 |
|  | 1980 |  .1210  |  .1252  |  –.0037 |
|  |  |  .6197  |  .7438  |  –.1120 |

 *a.* The average return for T-bills over this period was:

 Average return = .6197/8

 Average return = .0775, or 7.75%

 And the average inflation rate was:

1. Average inflation = .7438/8
2. Average inflation = .0930, or 9.30%

*b.* Using the equation for variance, we find the variance for T-bills over this period was:

 Variance = 1/7[(.0729 – .0775)2 + (.0799 – .0775)2 + (.0587 – .0775)2 + (.0507 – .0775)2 +

 (.0545 – .0775)2 + (.0764 – .0775)2 + (.1056 – .0775)2 + (.1210 − .0775)2]

 Variance = .000616

 And the standard deviation for T-bills was:

 Standard deviation = (.000616)1/2

 Standard deviation = .0248, or 2.48%

 The variance of inflation over this period was:

 Variance = 1/7[(.0871 – .0930)2 + (.1234 – .0930)2 + (.0694 – .0930)2 + (.0486 – .0930)2 +

 (.0670 – .0930)2 + (.0902 – .0930)2 + (.1329 – .0930)2 + (.1252 − .0930)2]

 Variance = .000971

 And the standard deviation of inflation was:

 Standard deviation = (.000971)1/2

 Standard deviation = .0312, or 3.12%

 *c*. The average observed real return over this period was:

 Average observed real return = –.1120/8

 Average observed real return = –.0140, or –1.40%

 *d*. The statement that T-bills have no risk refers to the fact that there is only an extremely small chance of the government defaulting, so there is little default risk. Since T-bills are short term, there is also very limited interest rate risk. However, as this example shows, there is inflation risk, i.e. the purchasing power of the investment can actually decline over time even if the investor is earning a positive return.

**23.** To find the return on the coupon bond, we first need to find the price of the bond today. Since one year has elapsed, the bond now has six years to maturity, so the price today is:

 P1 = $58(PVIFA5.4%,6) + $1,000/1.0546

 P1 = $1,020.05

 You received the coupon payments on the bond, so the nominal return was:

 *R* = ($1,020.05 – 1,027.50 + 58)/$1,027.50

 *R* = .0492, or 4.92%

 And using the Fisher equation to find the real return, we get:

 *r* = 1.0492/1.029 – 1

 *r* = .0196, or 1.96%

***CHAPTER 11***

**RISK AND RETURN: *THE CAPITAL ASSET PRICING MODEL (CAPM)***

# Answers to Concepts Review and Critical Thinking Questions

**1.** Some of the risk in holding any asset is unique to the asset in question. By investing in a variety of assets, this unique portion of the total risk can be eliminated at little cost. On the other hand, there are some risks that affect all investments. This portion of the total risk of an asset cannot be costlessly eliminated. In other words, systematic risk can be controlled, but only by a costly reduction in expected returns.

**2.** *a.* systematic

 *b.* unsystematic

 *c.* both; probably mostly systematic

 *d.* unsystematic

 *e.* unsystematic

 *f.* systematic

**3.** No to both questions. The portfolio expected return is a weighted average of the asset’s returns, so it must be less than the largest asset return and greater than the smallest asset return.

**4.** False. The variance of the individual assets is a measure of the total risk. The variance on a well-diversified portfolio is a function of systematic risk only.

**5.** Yes, the standard deviation can be less than that of every asset in the portfolio. However, βp cannot be less than the smallest beta because βp is a weighted average of the individual asset betas.

**6.** Yes. It is possible, in theory, to construct a zero beta portfolio of risky assets whose return would be equal to the risk-free rate. It is also possible to have a negative beta; the return would be less than the risk-free rate. A negative beta asset would carry a negative risk premium because of its value as a diversification instrument.

**7.** The covariance is a more appropriate measure of a security’s risk in a well-diversified portfolio because the covariance reflects the effect of the security on the variance of the portfolio. Investors are concerned with the variance of their portfolios and not the variance of the individual securities. Since covariance measures the impact of an individual security on the variance of the portfolio, covariance is the appropriate measure of risk.

**8.** If we assume that the market has not stayed constant during the past three years, then the lack in movement of Southern Co.’s stock price only indicates that the stock either has a standard deviation or a beta that is very near to zero. The large amount of movement in Texas Instruments’ (TIs’) stock price does not imply that the firm’s beta is high. Total volatility (the price fluctuation) is a function of both systematic and unsystematic risks. The beta only reflects the systematic risk. Observing the standard deviation of price movements does not indicate whether the price changes were due to systematic factors or firm specific factors. Thus, if you observe large stock price movements like that of TI, you cannot claim that the beta of the stock is high. All you know is that the total risk of TI is high.

**9.** The wide fluctuations in the price of oil stocks do not indicate that these stocks are a poor investment. If an oil stock is purchased as part of a well-diversified portfolio, only its contribution to the risk of the entire portfolio matters. This contribution is measured by systematic risk or beta. Since price fluctuations in oil stocks reflect diversifiable plus non-diversifiable risks, observing the standard deviation of price movements is not an adequate measure of the appropriateness of adding oil stocks to a portfolio.

**10.** The statement is false. If a security has a negative beta, investors would want to hold the asset to reduce the variability of their portfolios. Those assets will have expected returns that are lower than the risk-free rate. To see this, examine the Capital Asset Pricing Model:

 E(*R*S) = *R*f + βS[E(*R*M) – *R*f]

 If βS < 0, then the E(*R*S) < *R*f

**Solutions to Questions and Problems**

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 *Basic*

**1.** The portfolio weight of an asset is total investment in that asset divided by the total portfolio value. First, we will find the portfolio value, which is:

 Total value = 145($47) + 130($86)

 Total value = $17,995

 The portfolio weight for each stock is:

 *X*A = 145($47)/$17,995

 *X*A = .3787

 *X*B = 130($86)/$17,995

 *X*B = .6213

**2.** The expected return of a portfolio is the sum of the weight of each asset times the expected return of each asset. The total value of the portfolio is:

 Total value = $3,100 + 4,600

 Total value = $7,700

 So, the expected return of this portfolio is:

 E(*R*p) = ($3,100/$7,700)(.098) + ($4,600/$7,700)(.127)

 E(*R*p) = .1153, or 11.53%

**3.** The expected return of a portfolio is the sum of the weight of each asset times the expected return of each asset. So, the expected return of the portfolio is:

 E(*R*p) = .20(.105) + .45(.161) + .35(.124)

 E(*R*p) = .1369, or 13.69%

**4.** Here we are given the expected return of the portfolio and the expected return of each asset in the portfolio and are asked to find the weight of each asset. We can use the equation for the expected return of a portfolio to solve this problem. Since the total weight of a portfolio must equal 1 (100%), the weight of Stock Y must be one minus the weight of Stock X. Mathematically speaking, this means:

 E(*R*p) = .112 = .127*X*X + .091(1 – *X*X)

 We can now solve this equation for the weight of Stock X as:

 .112 = .127*X*X  + .091 – .091*X*X

 .021 = .036*X*X

 *X*X = .5833

 So, the dollar amount invested in Stock X is the weight of Stock X times the total portfolio value, or:

 Investment in X = .5833($10,000)

 Investment in X = $5,833.33

 And the dollar amount invested in Stock Y is:

 Investment in Y = (1 – .5833)($10,000)

 Investment in Y = $4,166.67

**5.** The expected return of an asset is the sum of the probability of each state occurring times the rate of return if that state occurs. So, the expected return of each stock asset is:

 E(*R*A) = .25(.06) + .55(.07) + .20(.11)

 E(*R*A) = .0755, or 7.55%

 E(*R*B) = .25(–.20) + .55(.13) + .20(.33)

 E(*R*B) = .0875, or 8.75%

 To calculate the standard deviation, we first need to calculate the variance. To find the variance, we find the squared deviations from the expected return. We then multiply each possible squared deviation by its probability, and then sum. The result is the variance. So, the variance and standard deviation of each stock are:

 σA2 =.25(.06 – .0755)2 + .55(.07 – .0755)2 + .20(.11 – .0755)2

 σA2 = .00031

 σA = .000311/2

 σA = .0177, or 1.77%

 σB2 =.25(–.20 – .0875)2 + .55(.13 – .0875)2 + .20(.33 – .0875)2

 σB2 = .03342

 σB = .033421/2

 σB = .1828, or 18.28%

**6.** The expected return of an asset is the sum of the probability of each return occurring times the probability of that return occurring. So, the expected return of the stock is:

 E(*R*A) = .15(–.148) + .30(.031) + .45(.162) + .10(.348)

 E(*R*A) = .0948, or 9.48%

 To calculate the standard deviation, we first need to calculate the variance. To find the variance, we find the squared deviations from the expected return. We then multiply each possible squared deviation by its probability, and then add all of these up. The result is the variance. So, the variance and standard deviation are:

 σ2 =.15(–.148 – .0948)2 + .30(.031 – .0948)2 + .45(.162 – .0948)2 + .10(.348 – .0948)2

 σ2 = .01851

σ =.018511/2

 σ = .1360, or 13.60%

**7.** The expected return of a portfolio is the sum of the weight of each asset times the expected return of each asset. So, the expected return of the portfolio is:

 E(*R*p) = .15(.09) + .60(.11) + .25(.14)

 E(*R*p) = .1145, or 11.45%

 If we own this portfolio, we would expect to earn a return of 11.45 percent.

**8.** *a.* To find the expected return of the portfolio, we need to find the return of the portfolio in each state of the economy. This portfolio is a special case since all three assets have the same weight. To find the expected return in an equally weighted portfolio, we can sum the returns of each asset and divide by the number of assets, so the expected return of the portfolio in each state of the economy is:

 Boom: *R*p = (.06 + .16 + .33)/3

 *R*p = .1833, or 18.33%

 Bust: *R*p = (.14 + .02 − .06)/3

 *R*p = .0333, or 3.33%

 To find the expected return of the portfolio, we multiply the return in each state of the economy by the probability of that state occurring, and then sum. Doing this, we find:

 E(*R*p) = .75(.1833) + .25(.0333)

 E(*R*p) = .1458, or 14.58%

 *b.* This portfolio does not have an equal weight in each asset. We still need to find the return of the portfolio in each state of the economy. To do this, we will multiply the return of each asset by its portfolio weight and then sum the products to get the portfolio return in each state of the economy. Doing so, we get:

 Boom: *R*p = .20(.06) +.20(.16) + .60(.33)

 *R*p = .2420, or 24.20%

 Bust: *R*p = .20(.14) +.20(.02) + .60(−.06)

 *R*p = –.0040, or –.40%

 And the expected return of the portfolio is:

 E(*R*p) = .75(.2420) + .25(−.0040)

 E(*R*p) = .1805, or 18.05%

 To find the variance, we find the squared deviations from the expected return. We then multiply each possible squared deviation by its probability, and then sum. The result is the variance. So, the variance of the portfolio is:

 σp2 = .75(.2420 – .1805)2 + .25(−.0040 – .1805)2

 σp2 = .011347

**9.** *a.* This portfolio does not have an equal weight in each asset. We first need to find the return of the portfolio in each state of the economy. To do this, we will multiply the return of each asset by its portfolio weight and then sum the products to get the portfolio return in each state of the economy. Doing so, we get:

 Boom: *R*p = .30(.24) + .40(.45) + .30(.33)

 *R*p = .3510, or 35.10%

 Good: *R*p = .30(.09) + .40(.10) + .30(.15)

 *R*p = .1120, or 11.20%

 Poor: *R*p = .30(.03) + .40(–.10) + .30(–.05)

 *R*p = –.0460, or –4.60%

 Bust: *R*p = .30(–.05) + .40(–.25) + .30(–.09)

 *R*p = –.1420, or –14.20%

 And the expected return of the portfolio is:

 E(*R*p) = .20(.3510) + .35(.1120) + .40(–.0460) + .05(–.1420)

 E(*R*p) = .0839, or 8.39%

 *b.* To calculate the standard deviation, we first need to calculate the variance. To find the variance, we find the squared deviations from the expected return. We then multiply each possible squared deviation by its probability, and then sum. The result is the variance. So, the variance and standard deviation of the portfolio are:

 σp2 = .20(.3510 – .0839)2 + .35(.1120 – .0839)2 + .40(–.0460 – .0839)2 + .05(–.1420 – .0839)2

 σp2 = .02385

 σp = .023851/2

 σp = .1544, or 15.44%

**10.** The beta of a portfolio is the sum of the weight of each asset times the beta of each asset. So, the beta of the portfolio is:

 βp = .20(.75) + .30(1.90) + .15(1.38) + .35(1.16)

 βp = 1.33

**11.** The beta of a portfolio is the sum of the weight of each asset times the beta of each asset. If the portfolio is as risky as the market it must have the same beta as the market. Since the beta of the market is 1.0, we know the beta of our portfolio is 1.0. We also need to remember that the beta of the risk-free asset is zero. It has to be zero since the asset has no risk. Setting up the equation for the beta of our portfolio, we get:

 βp = 1.0 = 1/3(0) + 1/3(1.61) + 1/3(βX)

 Solving for the beta of Stock X, we get:

 βX = 1.39

**12.** CAPM states the relationship between the risk of an asset and its expected return. CAPM is:

 E(*R*i) = *R*f + [E(*R*M) – *R*f] × βi

 Substituting the values we are given, we find:

 E(*R*i) = .038 + (.111 – .038)(1.15)

 E(*R*i) = .1220, or 12.20%

**13.** We are given the values for the CAPM except for the β of the stock. We need to substitute these values into the CAPM, and solve for the β of the stock. One important thing we need to realize is that we are given the market risk premium. The market risk premium is the expected return of the market minus the risk-free rate. We must be careful not to use this value as the expected return of the market. Using the CAPM, we find:

 E(*R*i) = .104 = .038 + .07βi

 βi = .94

**14.** Here we need to find the expected return of the market using the CAPM. Substituting the values given, and solving for the expected return of the market, we find:

 E(*R*i) = .127 = .042 + [E(*R*M) – .042](1.20)

 E(*R*M) = .1128, or 11.28%

**15.** Here we need to find the risk-free rate using the CAPM. Substituting the values given, and solving for the risk-free rate, we find:

 E(*R*i) = .109 = *R*f + (.118 – *R*f)(.90)

 .109 = *R*f + .1062 – .90*R*f

 *R*f = .0280, or 2.80%

**16.** *a.* We have a special case where the portfolio is equally weighted, so we can sum the returns of each asset and divide by the number of assets. The expected return of the portfolio is:

 E(*R*p) = (.116 + .036)/2

 E(*R*p) = .0760, or 7.60%

 *b.* We need to find the portfolio weights that result in a portfolio with a β of .50. We know the β of the risk-free asset is zero. We also know the weight of the risk-free asset is one minus the weight of the stock since the portfolio weights must sum to one, or 100 percent. So:

 βp = .50 = *X*S(1.08) + (1 – *X*S)(0)

 .50 = 1.08*X*S + 0 – 0*X*S

 *X*S = .50/1.08

 *X*S = .4630

 And, the weight of the risk-free asset is:

 *XR*f = 1 – .4630

 *XR*f = .5370

 *c.* We need to find the portfolio weights that result in a portfolio with an expected return of 10 percent. We also know the weight of the risk-free asset is one minus the weight of the stock since the portfolio weights must sum to one, or 100 percent. So:

 E(*R*p) = .105 = .116*X*S + .036(1 – *X*S)

 .105 = .116*X*S + .036 – .036*X*S

 *X*S = .8625

 So, the β of the portfolio will be:

 βp = .8625(1.08) + (1 – .8625)(0)

 βp = .932

 *d.* Solving for the β of the portfolio as we did in part *b*, we find:

 βp = 2.16 = *X*S(1.08) + (1 – *X*S)(0)

 *X*S = 2.16/1.08

 *X*S = 2

 *XR*f = 1 – 2

 *XR*f = –1

 The portfolio is invested 200% in the stock and –100% in the risk-free asset. This represents borrowing at the risk-free rate to buy more of the stock.

**17.** First, we need to find the β of the portfolio. The β of the risk-free asset is zero, and the weight of the risk-free asset is one minus the weight of the stock, so the β of the portfolio is:

 ßp = *X*W(1.2) + (1 – *X*W)(0) = 1.2*X*W

So, to find the β of the portfolio for any weight of the stock, we multiply the weight of the stock times its β.

 Even though we are solving for the β and expected return of a portfolio of one stock and the risk-free asset for different portfolio weights, we are really solving for the SML. Any combination of this stock and the risk-free asset will fall on the SML. For that matter, a portfolio of any stock and the risk-free asset, or any portfolio of stocks, will fall on the SML. We know the slope of the SML line is the market risk premium, so using the CAPM and the information concerning this stock, the market risk premium is:

 E(*R*W) = .123 = .04 + MRP(1.20)

 MRP = .083/1.2

 MRP = .0692, or 6.92%

 So, now we know the CAPM equation for any stock is:

 E(*R*p) = .04 + .0692βp

 The slope of the SML is equal to the market risk premium, which is .0692. Using these equations to fill in the table, we get the following results:

 *X*W E(*R*p) ßp

 0% .0400 0

 25 .0608 .300

 50 .0815 .600

 75 .1023 .900

 100 .1230 1.200

 125 .1438 1.500

 150 .1645 1.800

**18.** There are two ways to correctly answer this question. We will work through both. First, we can use the CAPM. Substituting in the value we are given for each stock, we find:

 E(*R*Y) = .045 + .071(1.15)

 E(*R*Y) = .1267, or 12.67%

 It is given in the problem that the expected return of Stock Y is 11.8 percent, but according to the CAPM, the return of the stock based on its level of risk should be 12.67 percent. This means the stock return is too low, given its level of risk. Stock Y plots below the SML and is overvalued. In other words, its price must decrease to increase the expected return to 12.67 percent.

 For Stock Z, we find:

 E(*R*Z) = .045 + .071(.85)

 E(*R*Z) = .1054, or 10.54%

 The return given for Stock Z is 10.7 percent, but, according to the CAPM, the expected return of the stock should be 10.54 percent based on its level of risk. Stock Z plots above the SML and is undervalued. In other words, its price must increase to decrease the expected return to 10.54 percent.

 We can also answer this question using the reward-to-risk ratio. All assets must have the same reward-to-risk ratio, that is, every asset must have the same ratio of the asset risk premium to its beta. This follows from the linearity of the SML in Figure 11.11. The reward-to-risk ratio is the risk premium of the asset divided by its β. This is also known as the Treynor ratio or Treynor index. We are given the market risk premium, and we know the β of the market is one, so the reward-to-risk ratio for the market is .071, or 7.1 percent. Calculating the reward-to-risk ratio for Stock Y, we find:

 Reward-to-risk ratio Y = (.118 – .045)/1.15 = .0635

 The reward-to-risk ratio for Stock Y is too low, which means the stock plots below the SML, and the stock is overvalued. Its price must decrease until its reward-to-risk ratio is equal to the market reward-to-risk ratio. For Stock Z, we find:

 Reward-to-risk ratio Z = (.107 – .045)/.85 = .0729

 The reward-to-risk ratio for Stock Z is too high, which means the stock plots above the SML, and the stock is undervalued. Its price must increase until its reward-to-risk ratio is equal to the market reward-to-risk ratio.

**19.** We need to set the reward-to-risk ratios of the two assets equal to each other (see the previous problem), which is:

 (.118 – *R*f)/1.15 = (.107 – *R*f)/.85

 We can cross multiply to get:

 .85(.118 – *R*f) = 1.15(.107 – *R*f)

 Solving for the risk-free rate, we find:

 .1003 – .85*R*f = .1231 – 1.15*R*f

 *R*f = .0758, or 7.58%

 *Intermediate*

**20.** For a portfolio that is equally invested in large-company stocks and long-term bonds:

 Return = (12.1% + 6.0%)/2

 Return = 9.05%

 For a portfolio that is equally invested in small stocks and Treasury bills:

 Return = (16.5% + 3.5%)/2

 Return = 10.00%

**21.** We know that the reward-to-risk ratios for all assets must be equal (See Question 19). This can be expressed as:

 [E(*R*A) – *R*f]/βA = [E(*R*B) – *R*f]/βB

 The numerator of each equation is the risk premium of the asset, so:

 RPA/βA = RPB/βB

 We can rearrange this equation to get:

 βB/βA = RPB/RPA

 If the reward-to-risk ratios are the same, the ratio of the betas of the assets is equal to the ratio of the risk premiums of the assets.

**22.** *a.* We need to find the return of the portfolio in each state of the economy. To do this, we will multiply the return of each asset by its portfolio weight and then sum the products to get the portfolio return in each state of the economy. Doing so, we get:

 Boom: *R*p = .4(.25) + .4(.35) + .2(.40)

 *R*p = .3200, or 32.00%

 Normal: *R*p = .4(.18) + .4(.13) + .2(.03)

 *R*p = .1300, or 13.00%

 Bust: *R*p = .4(.03) + .4(–.18) + .2(–.45)

 *R*p = –.1500, or –15.00%

 And the expected return of the portfolio is:

 E(*R*p) = .25(.32) + .55(.130) + .20(–.150)

 E(*R*p) = .1215, or 12.15%

 To calculate the standard deviation, we first need to calculate the variance. To find the variance, we find the squared deviations from the expected return. We then multiply each possible squared deviation by its probability, then add all of these up. The result is the variance. So, the variance and standard deviation of the portfolio are:

 σ2p = .25(.32 – .1215)2 + .55(.130 – .1215)2 + .20(–.150 – .1215)2

 σ2p = .02463

 σp = .024631/2

 σp = .1569, or 15.69%

 *b.* The risk premium is the return of a risky asset minus the risk-free rate. T-bills are often used as the risk-free rate, so:

 RPi = E(*R*p) – *R*f

 RPi = .1215 – .038

 RPi = .0835, or 8.35%

 *c.* The approximate expected real return is the expected nominal return minus the inflation rate, so:

 Approximate expected real return = .1215 – .035

 Approximate expected real return = .0865, or 8.65%

 To find the exact real return, we will use the Fisher equation. Doing so, we get:

 1 + E(*Ri*) = (1 + *h*)[1 + *e*(*ri*)]

 1.1215 = (1.0350)[1 + *e*(*ri*)]

 *e*(*ri*) = (1.1215/1.035) – 1

 *e*(*ri*) = .0836, or 8.36%

 The approximate real risk-free rate is:

 Approximate expected real return = .038 – .035

 Approximate expected real return = .003, or .30%

 And using the Fisher effect for the exact real risk-free rate, we find:

 1 + E(*Ri*) = (1 + *h*)[1 + *e*(*ri*)]

 1.038 = (1.0350)[1 + *e*(*ri*)]

 *e*(*ri*) = (1.038/1.035) – 1

 *e*(*ri*) = .0029, or .29%

 The approximate real risk premium is the approximate expected real return minus the risk-free rate, so:

 Approximate expected real risk premium = .0865 – .003

 Approximate expected real risk premium = .0835, or 8.35%

 The exact real risk premium is the exact real return minus the risk-free rate, so:

 Exact expected real risk premium = .0836 – .0029

 Exact expected real risk premium = .0807, or 8.07%

**23.** We know the total portfolio value and the investment of two stocks in the portfolio, so we can find the weight of these two stocks. The weights of Stock A and Stock B are:

 *X*A = $190,000/$1,000,000

 *X*A = .19

 *X*B = $325,000/$1,000,000

 *X*B = .325

 Since the portfolio is as risky as the market, the β of the portfolio must be equal to one. We also know the β of the risk-free asset is zero. We can use the equation for the β of a portfolio to find the weight of the third stock. Doing so, we find:

 βp = 1.0 = *X*A(.83) + *X*B(1.19) + *X*C(1.45) + *XR*f(0)

 Solving for the weight of Stock C, we find:

 *X*C = .31417241

 So, the dollar investment in Stock C must be:

 Invest in Stock C = .31417241($1,000,000)

 Invest in Stock C = $314,172.41

 We also know the total portfolio weight must be one, so the weight of the risk-free asset must be one minus the asset weight we know, or:

 1 = *X*A + *X*B + *X*C + *XR*f

 1 = .19 + .325 + .31417241 + *XR*f

 *XR*f = .17082759

 So, the dollar investment in the risk-free asset must be:

 Invest in risk-free asset = .17082759($1,000,000)

 Invest in risk-free asset = $170,827.59

**24.** We are given the expected return of the assets in the portfolio. We also know the sum of the weights of each asset must be equal to one. Using this relationship, we can express the expected return of the portfolio as:

 E(*Rp*) = .127 = *X*X(.114) + *X*Y(.0868)

 .127 = *X*X(.114) + (1 – *X*X)(.0868)

 .127 = .114*X*X + .0868 – .0868*X*X

 .0402 = .0272*X*X

 *X*X = 1.47794

 And the weight of Stock Y is:

 *X*Y = 1 – 1.47794

 *X*Y = –.47794

 The amount to invest in Stock Y is:

 Investment in Stock Y = –.47794($100,000)

 Investment in Stock Y = –$47,794.12

 A negative portfolio weight means that you short sell the stock. If you are unfamiliar with short selling, it means you borrow a stock today and sell it. You must then purchase the stock at a later date to repay the borrowed stock. If you short sell a stock, you make a profit if the stock decreases in value.

**25.** The expected return of an asset is the sum of the probability of each state occurring times the rate of return if that state occurs. So, the expected return of each stock is:

 E(*R*A) = .33(.099) + .33(.113) + .33(.059)

 E(*R*A) = .0903, or 9.03%

 E(*R*B) = .33(–.073) + .33(.128) + .33(.293)

 E(*R*B) = .1160, or 1160%

 To calculate the standard deviation, we first need to calculate the variance. To find the variance, we find the squared deviations from the expected return. We then multiply each possible squared deviation by its probability, and then sum. The result is the variance. So, the variance and standard deviation of Stock A are:

 σ =.33(.099 – .0903)2 + .33(.113 – .0903)2 + .33(.059 – .0903)2

 σ = .00052

 σA = .000521/2

 σA = .0229, or 2.29%

 And the standard deviation of Stock B is:

 σ =.33(–.073 – .1160)2 + .33(.128 – .1160)2 + .33(.293 – .1160)2

 σ = .02240

 σB = .022401/2

 σB = .1497, or 14.97%

 To find the covariance, we multiply each possible state times the product of each asset’s deviation from the mean in that state. The sum of these products is the covariance. So, the covariance is:

 Cov(A,B) = .33(.099 – .0903)(–.073 – .1160) + .33(.113 – .0903)(.128 – .1160)

 + .33(.059 – .0903)(.293 – .1160)

 Cov(A,B) = –.002304

 And the correlation is:

 ρA,B = Cov(A,B)/σAσB

 ρA,B = –.002304/(.0229)(.1497)

 ρA,B = –.6728

**26.** The expected return of an asset is the sum of the probability of each state occurring times the rate of return if that state occurs. So, the expected return of each stock is:

 E(*R*J) = .30(–.050) + .55(.118) + .15(.274)

 E(*R*J) = .0910, or 9.10%

 E(*R*K) = .30(.029) + .55(.074) + .15(.098)

 E(*R*K) = .0641, or 6.41%

 To calculate the standard deviation, we first need to calculate the variance. To find the variance, we find the squared deviations from the expected return. We then multiply each possible squared deviation by its probability, and then sum. The result is the variance. So, the variance and standard deviation of Stock J are:

 σ =.30(–.050 – .0910)2 + .55(.118 – .0910)2 + .15(.274 – .0910)2

 σ= .01139

 σJ = .011391/2

 σJ = .1067, or 10.67%

 And the standard deviation of Stock K is:

 σ =.30(.029 – .0641)2 + .55(.074 – .0641)2 + .15(.098 – .0641)2

 σ = .00060

 σK = .000601/2

 σK = .0244, or 2.44%

 To find the covariance, we multiply each possible state times the product of each asset’s deviation from the mean in that state. The sum of these products is the covariance. So, the covariance is:

 Cov(J,K) = .30(–.050 – .0910)(.029 – .0641) + .55(.118 – .0910)(.074 – .0641)

 + .15(.274 – .0910)(.098 – .0641)

 Cov(J,K) = .002562

 And the correlation is:

 ρJ,K = Cov(J,K)/σJσK

 ρJ,K = .002562/(.1067)(.0244)

 ρJ,K = .9836

**27.** *a.* The expected return of the portfolio is the sum of the weight of each asset times the expected return of each asset, so:

 E(*R*P) = *X*FE(*R*F) + *X*GE(*R*G)

 E(*R*P) = .40(.10) + .60(.13)

 E(*R*P) = .1180, or 11.80%

 *b*. The variance of a portfolio of two assets can be expressed as:

 σ = *X*σ + *X*σ + 2*X*F*X*G σFσGρF,G

 σ = .402(.532) + .602(.792) + 2(.40)(.60)(.53)(.79)(.35)

 σ = .33996

 So, the standard deviation is:

 σP = .339961/2

 σP = .5831, or 58.31%

**28.** *a.* The expected return of the portfolio is the sum of the weight of each asset times the expected return of each asset, so:

 E(*R*P) = *X*AE(*R*A) + *X*BE(*R*B)

 E(*R*P) = .40(.11) + .60(.13)

 E(*R*P) = .1220, or 12.20%

 The variance of a portfolio of two assets can be expressed as:

 σ = *X*σ + *X*σ + 2*X*A*X*BσAσBρA,B

 σ = .402(.472) + .602(.812) + 2(.40)(.60)(.47)(.81)(.50)

 σ = .36291

 So, the standard deviation is:

 σP = .362911/2

 σP = .6024, or 60.24%

 *b.* σ = *X*σ + *X*σ+ 2*X*A*X*BσAσBρA,B

 σ = .402(.472) + .602(.812) + 2(.40)(.60)(.47)(.81)(–.50)

 σ = .18017

 So, the standard deviation is:

 σ = .180171/2

 σ = .4245, or 42.45%

 *c.* As Stock A and Stock B become less correlated, or more negatively correlated, the standard deviation of the portfolio decreases.

**29.** *a*. (i) Using the equation to calculate beta, we find:

 βA = (ρA,M)(σA)/σM

 .85 = (ρA,M)(.31)/.20

 ρA,M = .55

 (ii) Using the equation to calculate beta, we find:

 βB = (ρB,M)(σB)/σM

 1.40 = (.50)(σB)/.20

 σB = .56

 (iii) Using the equation to calculate beta, we find:

 βC = (ρC,M)(σC)/σM

 βC = (.35)(.65)/.20

 βC = 1.14

(iv) The market has a correlation of 1 with itself.

 (v) The beta of the market is 1.

 (vi) The risk-free asset has zero standard deviation.

 (vii) The risk-free asset has zero correlation with the market portfolio.

 (viii) The beta of the risk-free asset is 0.

*b.* Using the CAPM to find the expected return of the stock, we find:

 *Firm A:*

 E(*R*A) = *R*f + βA[E(*R*M) – *R*f]

E(*R*A) **=** .05 + .85(.12 – .05)

 E(*R*A) = .1095, or 10.95%

 According to the CAPM, the expected return on Firm A’s stock should be 10.95 percent. However, the expected return on Firm A’s stock given in the table is only 10 percent. Therefore, Firm A’s stock is overpriced, and you should sell it.

 *Firm B:*

 E(*R*B) = *R*f + βB[E(*R*M) – *R*f]

E(*R*B) **=** .05 + 1.4(.12 – .05)

 E(*R*B) = .1480, or 14.80%

 According to the CAPM, the expected return on Firm B’s stock should be 14.80 percent. However, the expected return on Firm B’s stock given in the table is 14 percent. Therefore, Firm B’s stock is overpriced, and you should sell it.

 *Firm C:*

 E(*R*C) = *R*f + βC[E(*R*M) – *R*f]

E(*R*C) **=** .05 + 1.14(.12 – .05)

 E(*R*C) = .1296, or 12.96%

 According to the CAPM, the expected return on Firm C’s stock should be 12.96 percent. However, the expected return on Firm C’s stock given in the table is 16 percent. Therefore, Firm C’s stock is underpriced, and you should buy it.

**30.** Because a well-diversified portfolio has no unsystematic risk, this portfolio should lie on the Capital Market Line (CML). The slope of the CML equals:

 SlopeCML = [E(*R*M) – *R*f]/σM

 SlopeCML = (.115 – .041)/.19

 SlopeCML = .38947

 *a.* The expected return on the portfolio equals:

 E(*R*P) = *R*f + SlopeCML(σP)

 E(*R*P) = .041 + .38947(.09)

 E(*R*P) = .0761, or 7.61%

 *b.* The expected return on the portfolio equals:

 E(*R*P) = *R*f + SlopeCML(σP)

 .20 = .041 + .38947(σP)

 σP = .4082, or 40.82%

**31.** First, we can calculate the standard deviation of the market portfolio using the Capital Market Line (CML). We know that the risk-free asset has a return of 4.1 percent and a standard deviation of zero and the portfolio has an expected return of 9 percent and a standard deviation of 16 percent. These two points must lie on the Capital Market Line. The slope of the Capital Market Line equals:

 SlopeCML = Rise/Run

 SlopeCML = Increase in expected return/Increase in standard deviation

 SlopeCML = (.09 – .041)/(.16 – 0)

 SlopeCML = .3063

 According to the Capital Market Line:

 E(*R*I) = *R*f + SlopeCML(σI)

 Since we know the expected return on the market portfolio, the risk-free rate, and the slope of the Capital Market Line, we can solve for the standard deviation of the market portfolio which is:

 E(*R*M) = *R*f + SlopeCML(σM)

 .11 = .041 + (.3063)(σM)

 σM = (.11 – .041)/.3063

 σM = .2253, or 22.53%

 Next, we can use the standard deviation of the market portfolio to solve for the beta of a security using the beta equation. Doing so, we find the beta of the security is:

 βI = (ρI,M)(σI)/σM

 βI = (.38)(.60)/.2253

 βI = 1.01

 Now we can use the beta of the security in the CAPM to find its expected return, which is:

 E(*R*I) = *R*f + βI[E(*R*M) – *R*f]

E(*R*I) **=** .041 + 1.01(.11 – .041)

 E(*R*I) = .1108, or 11.08%

**32.** First, we need to find the standard deviation of the market and the portfolio, which are:

 σM = .03911/2

 σM = .1977, or 19.77%

 σZ = .34071/2

 σZ = .5837, or 58.37%

 Now we can use the equation for beta to find the beta of the portfolio, which is:

 βZ = (ρZ,M)(σZ)/σM

βZ = (.31)(.5837)/.1977

 βZ = .92

 Now, we can use the CAPM to find the expected return of the portfolio, which is:

 E(*R*Z) = *R*f + βZ[E(*R*M) – *R*f]

E(*R*Z) **=** .044 + .92(.109 – .044)

 E(*R*Z) = .1035, or 10.35%

***CHAPTER 13***

**RISK, COST OF CAPITAL, AND CAPITAL BUDGETING**

**Answers to Concepts Review and Critical Thinking Questions**

**1.** No. The cost of capital depends on the risk of the project, not the source of the money.

**2.** Interest expense is tax-deductible. There is no difference between pretax and aftertax equity costs.

**3.** You are assuming that the new project’s risk is the same as the risk of the firm as a whole, and that the firm is financed entirely with equity.

**4.** Two primary advantages of the SML approach are that the model explicitly incorporates the relevant risk of the stock and the method is more widely applicable than is the DCF model, since the SML doesn’t make any assumptions about the firm’s dividends. The primary disadvantages of the SML method are (1) three parameters (the risk-free rate, the expected return on the market, and beta) must be estimated, and (2) the method essentially uses historical information to estimate these parameters. The risk-free rate is usually estimated to be the yield on very short maturity T-bills and is, hence, observable; the market risk premium is usually estimated from historical risk premiums and, hence, is not observable. The stock beta, which is unobservable, is usually estimated either by determining some average historical beta from the firm and the market’s return data, or by using beta estimates provided by analysts and investment firms.

**5.** The appropriate aftertax cost of debt to the company is the interest rate it would have to pay if it were to issue new debt today. Hence, if the YTM on outstanding bonds of the company is observed, the company has an accurate estimate of its cost of debt. If the debt is privately-placed, the firm could still estimate its cost of debt by (1) looking at the cost of debt for similar firms in similar risk classes, (2) looking at the average debt cost for firms with the same credit rating (assuming the firm’s private debt is rated), or (3) consulting analysts and investment bankers. Even if the debt is publicly traded, an additional complication arises when the firm has more than one issue outstanding; these issues rarely have the same yield because no two issues are ever completely homogeneous.

**6.** *a.* This only considers the dividend yield component of the required return on equity.

 *b.* This is the current yield only, not the promised yield to maturity. In addition, it is based on the book value of the liability, and it ignores taxes.

 *c.* Equity is inherently riskier than debt (except, perhaps, in the unusual case where a firm’s assets have a negative beta). For this reason, the cost of equity exceeds the cost of debt. If taxes are considered in this case, it can be seen that at reasonable tax rates, the cost of equity does exceed the cost of debt.

**7.** RSup = .12 + .75(.08) = .1800, or 18.00%

 Both should proceed. The appropriate discount rate does not depend on which company is investing; it depends on the risk of the project. Since Superior is in the business, it is closer to a pure play. Therefore, its cost of capital should be used. With an 18 percent cost of capital, the project has an NPV of $1 million regardless of who takes it.

**8.** If the different operating divisions were in much different risk classes, then separate cost of capital figures should be used for the different divisions; the use of a single, overall cost of capital would be inappropriate. If the single hurdle rate were used, riskier divisions would tend to receive more funds for investment projects, since their return would exceed the hurdle rate despite the fact that they may actually plot below the SML and, hence, be unprofitable projects on a risk-adjusted basis. The typical problem encountered in estimating the cost of capital for a division is that it rarely has its own securities traded on the market, so it is difficult to observe the market’s valuation of the risk of the division. Two typical ways around this are to use a pure play proxy for the division, or to use subjective adjustments of the overall firm hurdle rate based on the perceived risk of the division.

**9.** The discount rate for the projects should be lower than the rate implied by the security market line. The security market line is used to calculate the cost of equity. The appropriate discount rate for the projects is the firm’s weighted average cost of capital. Since the firm’s cost of debt is generally less that the firm’s cost of equity, the rate implied by the security market line will be too high.

**10.** Beta measures the responsiveness of a security's returns to movements in the market. Beta is determined by the cyclicality of a firm's revenues. This cyclicality is magnified by the firm's operating and financial leverage. The following three factors will impact the firm’s beta. (1) Revenues. The cyclicality of a firm's sales is an important factor in determining beta. In general, stock prices will rise when the economy expands and will fall when the economy contracts. As we said above, beta measures the responsiveness of a security's returns to movements in the market. Therefore, firms whose revenues are more responsive to movements in the economy will generally have higher betas than firms with less-cyclical revenues. (2) Operating leverage. Operating leverage is the percentage change in earnings before interest and taxes (EBIT) for a percentage change in sales. A firm with high operating leverage will have greater fluctuations in EBIT for a change in sales than a firm with low operating leverage. In this way, operating leverage magnifies the cyclicality of a firm's revenues, leading to a higher beta. (3) Financial leverage. Financial leverage arises from the use of debt in the firm's capital structure. A levered firm must make fixed interest payments regardless of its revenues. The effect of financial leverage on beta is analogous to the effect of operating leverage on beta. Fixed interest payments cause the percentage change in net income to be greater than the percentage change in EBIT, magnifying the cyclicality of a firm's revenues. Thus, returns on highly-levered stocks should be more responsive to movements in the market than the returns on stocks of firms with little or no debt in their capital structures.

**Solutions to Questions and Problems**

*NOTE: All end-of-chapter problems were solved using a spreadsheet. Many problems require multiple steps. Due to space and readability constraints, when these intermediate steps are included in this solutions manual, rounding may appear to have occurred. However, the final answer for each problem is found without rounding during any step in the problem.*

 *Basic*

**1.** With the information given, we can find the cost of equity using the CAPM. The cost of equity is:

*RS* = .027 + .95(.10 – .027)

 *RS* = .0964, or 9.64%

**2.** The pretax cost of debt is the YTM of the company’s bonds, so:

P0 = $950 = $30(PVIFA*R*%,34) + $1,000(PVIF*R*%,34)

 *R* = 3.245%

 *RB* = 2 × 3.245%

 *RB* = 6.49%

 And the aftertax cost of debt is:

Aftertax cost of debt = .0649(1 – .21)

 Aftertax cost of debt= .0513, or 5.13%

**3.** *a.* The pretax cost of debt is the YTM of the company’s bonds, so:

 P0 = $1,060 = $29.50(PVIFA*R*%,54) + $1,000(PVIF*R*%,54)

 *R* = 2.736%

 *RB* = 2 × 2.736%

 *RB* = 5.47%

*b.* The aftertax cost of debt is:

 Aftertax cost of debt = .0547(1 – .22)

 Aftertax cost of debt = .0427, or 4.27%

*c.* The aftertax rate is more relevant because that is the actual cost to the company.

**4.** The book value of debt is the total par value of all outstanding debt, so:

BVB = $25,000,000 + 60,000,000

 BVB = $85,000,000

 To find the market value of debt, we find the price of the bonds and multiply by the number of bonds. Alternatively, we can multiply the price quote of the bond times the par value of the bonds. Doing so, we find:

*B* = 1.06($25,000,000) + .68($60,000,000)

 *B* = $67,300,000

 The YTM of the zero coupon bonds is:

PZ = $680 = $1,000(PVIF*R*%,18)

 *R* = 2.166%

 YTM = 2 × 2.166%

 YTM = 4.33%

 So, the aftertax cost of the zero coupon bonds is:

 Aftertax cost of debt = .0433(1 – .22)

 Aftertax cost of debt = .0338, or 3.38%

The aftertax cost of debt for the company is the weighted average of the aftertax cost of debt for all outstanding bond issues. We need to use the market value weights of the bonds. The total aftertax cost of debt for the company is:

Aftertax cost of debt = .0427[1.06($25)/$67.3] + .0338[.68($60)/$67.3)

 Aftertax cost of debt = .0373, or 3.73%

**5.** Using the equation to calculate the WACC, we find:

 *R*WACC = .70(.109) + .30(.057)(1 – .23)

 *R*WACC = .0895, or 8.95%

**6.** Here we need to use the debt-equity ratio to calculate the WACC. Doing so, we find:

*R*WACC = .118(1/1.40) + .065(.40/1.40)(1 – .21)

 *R*WACC = .0990, or 9.90%

**7.** Here we have the WACC and need to find the debt-equity ratio of the company. Setting up the WACC equation, we find:

 *R*WACC = .0910 = .11(*S*/*V*) + .064(*B*/*V*)(1 – .21)

 Rearranging the equation, we find:

 .0910(*V*/*S*) = .11 + .064(.79)(*B*/*S*)

 Now we must realize that the *V*/*S* is just the equity multiplier, which is equal to:

 *V*/*S* = 1 + *B*/*S*

 .0910(*B*/S + 1) = .11 + .05056(*B*/*S*)

 Now we can solve for *B*/*S* as:

 .04044(*B*/*S*) = .019

 *B*/*S* = .4698

**8.** *a.* The book value of equity is the book value per share times the number of shares, and the book value of debt is the face value of the company’s debt, so:

 Equity = 7,600,000($4) = $30,400,000

 Debt = $80,000,000 + 65,000,000 = $145,000,000

 So, the total book value of the company is:

 Book value = $30,400,000 + 145,000,000 = $175,400,000

 And the book value weights of equity and debt are:

 Equity/Value = $30,400,000/$175,400,000 = .1733

 Debt/Value = 1 – Equity/Value = .8267

 *b.* The market value of equity is the share price times the number of shares, so:

 *S* = 7,600,000($67) = $509,200,000

 Using the relationship that the total market value of debt is the price quote times the par value of the bond, we find the market value of debt is:

 *B* = 1.095($80,000,000) + 1.124($65,000,000) = $160,660,000

 This makes the total market value of the company:

 *V* = $509,200,000 + 160,660,000 = $669,860,000

 And the market value weights of equity and debt are:

*S*/*V* = $509,200,000/$669,860,000 = .7602

 *B*/*V* = 1 – *S*/*V* = .2398

 *c.* The market value weights are more relevant.

**9.** First, we will find the cost of equity for the company. The information provided allows us to solve for the cost of equity using the CAPM, so:

 *R*S = .029 + 1.10(.07)

 *R*S = .1060, or 10.60%

 Next, we need to find the YTM on both bond issues. Doing so, we find:

 P1 = $1,095 = $34(PVIFA*R*%,18) + $1,000(PVIF*R*%,18)

 *R* = 2.725%

 YTM = 2.725% × 2 = 5.45%

 P2 = $1,124 = $35.50(PVIFA*R*%,50) + $1,000(PVIF*R*%,50)

 *R* = 3.062%

 YTM = 3.062% × 2 = 6.12%

 To find the weighted average aftertax cost of debt, we need the weight of each bond as a percentage of the total debt. We find:

 *X*B1 = 1.095($80,000,000)/$160,660,000 = .545

 *X*B2 = 1.124($65,000,000)/$160,660,000 = .455

Now we can multiply the weighted average cost of debt times one minus the tax rate to find the weighted average aftertax cost of debt. This gives us:

 *RB* = (1 – .23)[(.545)(.0545) + (.455)(.0612)]

 *RB* = .0443, or 4.43%

 Using these costs and the weight of debt we calculated earlier, the WACC is:

 *R*WACC = .7602(.1060) + .2398(.0443)

 *R*WACC = .0912, or 9.12%

**10.** *a.* Using the equation to calculate WACC, we find:

 *R*WACC = .101 = (1/1.38)(.12) + (.38/1.38)(1 – .25)*R*B

 *RB* = .0680, or 6.80%

 *b.* Using the equation to calculate WACC, we find:

 *R*WACC = .101 = (1/1.38)*R*S + (.38/1.38)(.064)

 *RS* = .1151, or 11.51%

**11.** We will begin by finding the market value of each type of financing. We find:

 *B* = 17,000($2,000)(1.05) = $35,700,000

 *S* = 425,000($67) = $28,475,000

 And the total market value of the firm is:

 *V* = $35,700,000 + 28,475,000

 *V* = $64,175,000

 Now, we can find the cost of equity using the CAPM. The cost of equity is:

 *RS* = .035 + .88(.07)

 *RS* = .0966, or 9.66%

 The cost of debt is the YTM of the bonds, so:

 P0 = $2,100 = $49(PVIFA*R*%,40) + $1,000(PVIF*R*%,40)

 *R* = 2.259%

 YTM = 2.259% × 2 = 4.52%

 And the aftertax cost of debt is:

 *RB* = (1 – .21)(.0452)

 *RB* = .0357, or 3.57%

 Now we have all of the components to calculate the WACC. The WACC is:

 *R*WACC = .0357($35,700,000/$64,175,000) + .0966($28,475,000/$64,175,000)

 *R*WACC = .0627, or 6.27%

 Notice that we didn’t include the (1 – *T*C) term in the WACC equation. We used the aftertax cost of debt in the equation, so the term is not needed here.

**12.** *a.* We will begin by finding the market value of each type of financing. We find:

 *B* = 175,000($1,000)(1.06) = $185,500,000

 *S* = 6,400,000($53) = $339,200,000

 And the total market value of the firm is:

 *V* = $185,500,000 + 339,200,000

 *V* = $524,700,000

 So, the market value weights of the company’s financing are:

 *B*/*V* = $185,500,000/$524,700,000 = .3535

 *S*/*V* = $339,200,000/$524,700,000 = .6465

 *b.* For projects equally as risky as the firm itself, the WACC should be used as the discount rate.

 First we can find the cost of equity using the CAPM. The cost of equity is:

 *R*S = .031 + 1.15(.068)

 *R*S = .1092, or 10.92%

 The cost of debt is the YTM of the bonds, so:

 P0 = $1,060 = $31(PVIFA*R*%,50) + $1,000(PVIF*R*%,50)

 *R* = 2.872%

 YTM = 2.872% × 2 = 5.74%

 And the aftertax cost of debt is:

 *R*B = (1 – .22)(.0574)

 *R*B = .0448, or 4.48%

 Now we can calculate the WACC as:

 *R*WACC = .6465(.1092) + .3535(.0448)

 *R*WACC = .0864, or 8.64%

**13.** *a.* Projects Y and Z.

 *b.* Using the CAPM to consider the projects, we need to calculate the expected return of each project given its level of risk. This expected return should then be compared to the expected return of the project. If the return calculated using the CAPM is lower than the project expected return, we should accept the project; if not, we reject the project. After considering risk via the CAPM:

 E[W] = .035 + .75(.12 – .035) = .0988 > .094, so reject W

 E[X] = .035 + .90(.12 – .035) = .1115 < .112, so accept X

 E[Y] = .035 + 1.15(.12 – .035) = .1328 < .141, so accept Y

 E[Z] = .035 + 1.45 (.12 – .035) = .1583 > .155, so reject Z

1. Project X would be incorrectly rejected; Project Z would be incorrectly accepted.

***CHAPTER 3***

**LONG-TERM FINANCIAL PLANNING AND GROWTH**

**Answers to Concepts Review and Critical Thinking Questions**

**1.** Time trend analysis gives a picture of changes in the company’s financial situation over time. Comparing a firm to itself over time allows the financial manager to evaluate whether some aspects of the firm’s operations, finances, or investment activities have changed. Peer group analysis involves comparing the financial ratios and operating performance of a particular firm to a set of peer group firms in the same industry or line of business. Comparing a firm to its peers allows the financial manager to evaluate whether some aspects of the firm’s operations, finances, or investment activities are out of line with the norm, thereby providing some guidance on appropriate actions to take to adjust these ratios if appropriate. Both allow an investigation into what is different about a company from a financial perspective, but neither method gives an indication of whether the difference is positive or negative. For example, suppose a company’s current ratio is increasing over time. It could mean that the company had been facing liquidity problems in the past and is rectifying those problems, or it could mean the company has become less efficient in managing its current accounts. Similar arguments could be made for a peer group comparison. A company with a current ratio lower than its peers could be more efficient at managing its current accounts, or it could be facing liquidity problems. Neither analysis method tells us whether a ratio is good or bad; both show that something is different, and tell us where to look.

**2.** If a company is growing by opening new stores, then presumably total revenues would be rising. Comparing total sales at two different points in time might be misleading. Same-store sales control for this by only looking at revenues of stores open within a specific period.

**3.** The reason is that, ultimately, sales are the driving force behind a business. A firm’s assets, employees, and, in fact, just about every aspect of its operations and financing exist to directly or indirectly support sales. Put differently, a firm’s future need for things like capital assets, employees, inventory, and financing are determined by its future sales level.

**4.** Two assumptions of the sustainable growth formula are that the company does not want to sell new equity, and that financial policy is fixed. If the company raises outside equity, or increases its debt-equity ratio, it can grow at a higher rate than the sustainable growth rate. Of course, the company could also grow at a faster rate if its profit margin increases, if it changes its dividend policy by increasing the retention ratio, or its total asset turnover increases.

**5.** The sustainable growth rate is greater than 20 percent, because at a 20 percent growth rate the negative EFN indicates that there is excess financing still available. If the firm is 100 percent equity financed, then the sustainable and internal growth rates are equal and the internal growth rate would be greater than 20 percent. However, when the firm has some debt, the internal growth rate is always less than the sustainable growth rate, so it is ambiguous whether the internal growth rate would be greater than or less than 20 percent. If the retention ratio is increased, the firm will have more internal funding sources available, and it will have to take on more debt to keep the debt/equity ratio constant, so the EFN will decline. Conversely, if the retention ratio is decreased, the EFN will rise. If the retention rate is zero, both the internal and sustainable growth rates are zero, and the EFN will rise to the change in total assets.

**6.** Common-size financial statements provide the financial manager with a ratio analysis of the company. The common-size income statement can show, for example, that cost of goods sold as a percentage of sales is increasing. The common-size balance sheet can show a firm’s increasing reliance on debt as a form of financing. Common-size statements of cash flows are not calculated for a simple reason: There is no possible denominator.

**7.** It would reduce the external funds needed. If the company is not operating at full capacity, it would be able to increase sales without a commensurate increase in fixed assets.

**8.** ROE is a better measure of the company’s performance. ROE shows the percentage return earned on shareholder investment. Since the goal of a company is to maximize shareholder wealth, this ratio shows the company’s performance in achieving this goal over the period.

**9.** The EBITD/Assets ratio shows the company’s operating performance before interest, taxes, and depreciation. This ratio would show how a company has controlled costs. While taxes are a cost, and depreciation and amortization can be considered costs, they are not as easily controlled by company management. Conversely, depreciation and amortization can be altered by accounting choices. This ratio only uses costs directly related to operations in the numerator. As such, it gives a better metric to measure management performance over a period than does ROA.

**10.** Long-term liabilities and equity are investments made by investors in the company, either in the form of a loan or ownership. Return on investment is intended to measure the return the company earned from these investments. Return on investment will be higher than the return on assets for a company with current liabilities. To see this, realize that total assets must equal total debt and equity, and total debt and equity is equal to current liabilities plus long-term liabilities plus equity. So, return on investment could be calculated as net income divided by total assets minus current liabilities.

**11.** Presumably not, but, of course, if the product had been *much* less popular, then a similar fate would have awaited due to lack of sales.

**12.** Since customers did not pay until shipment, receivables rose. The firm’s NWC, but not its cash, increased. At the same time, costs were rising faster than cash revenues, so operating cash flow declined. The firm’s capital spending was also rising. Thus, all three components of cash flow from assets were negatively impacted.

**13.** Financing possibly could have been arranged if the company had taken quick enough action. Sometimes it becomes apparent that help is needed only when it is too late, again emphasizing the need for planning.

**14.** All three were important, but the lack of cash or, more generally, financial resources, ultimately spelled doom. An inadequate cash resource is usually cited as the most common cause of small business failure.

**15.** Demanding cash up front, increasing prices, subcontracting production, and improving financial resources via new owners or new sources of credit are some of the options. When orders exceed capacity, price increases may be especially beneficial.

**Solutions to Questions and Problems**

*NOTE: All end-of-chapter problems were solved using a spreadsheet. Many problems require multiple steps. Due to space and readability constraints, when these intermediate steps are included in this solutions manual, rounding may appear to have occurred. However, the final answer for each problem is found without rounding during any step in the problem.*

 *Basic*

**1.** Using the DuPont identity, the ROE is:

ROE = (Profit margin)(Total asset turnover)(Equity multiplier)

 ROE = (.061)(1.87)(1.35)

 ROE = .1540, or 15.40%

**2.** The equity multiplier is:

Equity multiplier = 1 + D/E

 Equity multiplier = 1 + .85

 Equity multiplier = 1.85

 One formula to calculate return on equity is:

 ROE = (ROA)(Equity multiplier )

 ROE = .073(1.85)

 ROE = .1351, or 13.51%

 ROE can also be calculated as:

 ROE = Net income/Total equity

 So, net income is:

 Net income = ROE(Total equity)

 Net income = .1351($910,000)

 Net income = $122,895.50

**3.** This is a multi-step problem involving several ratios. The ratios given are all part of the DuPont Identity. The only DuPont Identity ratio not given is the profit margin. If we know the profit margin, we can find the net income since sales are given. So, we begin with the DuPont Identity:

 ROE = .14 = (Profit margin)(Total asset turnover)(Equity multiplier)

 ROE = (Profit margin)(Sales/Total assets)(1 + D/E)

 Solving the DuPont Identity for profit margin, we get:

 Profit margin = [(ROE)(Total assets)]/[(1 + D/E)(Sales)]

 Profit margin = [(.14)($1,520)]/[(1 + 1.35)($3,300)]

 Profit margin = .0274

Now that we have the profit margin, we can use this number and the given sales figure to solve for net income:

 Profit margin = .0274 = Net income/Sales

 Net income = .0274($3,300)

 Net income = $90.55

**4.** An increase of sales to $42,112 is an increase of:

 Sales increase = ($42,112 – 37,600)/$37,600

 Sales increase = .1200, or 12.00%

 Assuming costs and assets increase proportionally, the pro forma financial statements will look like this:

 Pro forma income statement Pro forma balance sheet

 Sales $42,112.00 Assets $ 151,200.00 Debt $ 37,000.00

 Costs 29,232.00 Equity 105,151.20

 EBIT 12,880.00 Total $ 151,200.00 Total $142,151.20

 Taxes (21%) 2,704.80

 Net income $10,175.20

 The payout ratio is constant, so the dividends paid this year is the payout ratio from last year times net income, or:

 Dividends = ($2,700/$9,085)($10,175.20)

 Dividends = $3,024

 The addition to retained earnings is:

 Addition to retained earnings = $10,175.20 – 3,024

 Addition to retained earnings = $7,151.20

 And the new equity balance is:

 Equity = $98,000 + 7,151.20

 Equity = $105,151.20

So the EFN is:

 EFN = Total assets – Total liabilities and equity

EFN = $151,200 – 142,151.20

 EFN = $9,048.80

**5.** The maximum percentage sales increase without issuing new equity is the sustainable growth rate. To calculate the sustainable growth rate, we first need to calculate the ROE, which is:

 ROE = NI/TE

 ROE = $20,066/$88,000

 ROE = .2280, or 22.80%

 The plowback ratio, *b*, is one minus the payout ratio, so:

 *b* = 1 – .30

 *b* = .70

 Now we can use the sustainable growth rate equation to get:

 Sustainable growth rate = (ROE × b)/[1 – (ROE × b)]

 Sustainable growth rate = [.2280(.70)]/[1 – .2280(.70)]

 Sustainable growth rate = .1899, or 18.99%

 So, the maximum dollar increase in sales is:

 Maximum increase in sales = $49,000(.1899)

 Maximum increase in sales = $9,306.67

**6.** We need to calculate the retention ratio to calculate the sustainable growth rate. The retention ratio is:

*b* = 1 – .20

 *b* = .80

 Now we can use the sustainable growth rate equation to get:

 Sustainable growth rate = (ROE × *b*)/[1 – (ROE × *b*)]

 Sustainable growth rate = [.11(.80)]/[1 – .11(.80)]

 Sustainable growth rate = .0965, or 9.65%

**7.** We must first calculate the ROE using the DuPont ratio to calculate the sustainable growth rate. The ROE is:

 ROE = (PM)(TAT)(EM)

 ROE = (.057)(2.65)(1.60)

 ROE = .2417, or 24.17%

 The plowback ratio is one minus the dividend payout ratio, so:

 *b* = 1 – .70

 *b* = .30

 Now, we can use the sustainable growth rate equation to get:

 Sustainable growth rate = (ROE × *b*)/[1 – (ROE × *b*)]

 Sustainable growth rate = [.2417(.30)]/[1 – .2417(.30)]

 Sustainable growth rate = .0782, or 7.82%

**8.** An increase of sales to $9,462 is an increase of:

 Sales increase = ($9,462 – 8,300)/$8,300

 Sales increase = .14, or 14%

 Assuming costs and assets increase proportionally, the pro forma financial statements will look like this:

 Pro forma income statement Pro forma balance sheet

 Sales $ 9,462 Assets $ 21,774 Debt $ 8,400

 Costs 7,399 Equity 12,763

 Net income $ 2,063 Total $ 21,774 Total $ 21,163

 If no dividends are paid, the equity account will increase by the net income, so:

 Equity = $10,700 + 2,063

 Equity = $12,763

 So the EFN is:

 EFN = Total assets – Total liabilities and equity

 EFN = $21,774 – 21,163

 EFN = $611

**9.** *a.* First, we need to calculate the current sales and change in sales. The current sales are next year’s sales divided by one plus the growth rate, so:

 Current sales = Next year’s sales/(1 + *g*)

 Current sales = $320,000,000/(1 + .12)

 Current sales = $285,714,286

 And the change in sales is:

 Change in sales = $320,000,000 – 285,714,286

 Change in sales = $34,285,714

 We can now complete the current balance sheet. The current assets, fixed assets, and short-term debt are calculated as a percentage of current sales. The long-term debt and par value of stock are given. The plug variable is the addition to retained earnings. So:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|   | Assets |   |   | Liabilities and equity |   |
|   | Current assets | $57,142,857 |   | Short-term debt | $42,857,143 |
|   |   |  |   | Long-term debt | $110,000,000 |
|   |   |  |   |   |  |
|   | Fixed assets | 200,000,000 |   | Common stock | $45,000,000 |
|   |   |  |   | Accumulated retained earnings | 59,285,714 |
|   |   |  |   |  Total equity | $104,285,714 |
|   |   |  |   |   |  |
|   | Total assets | $257,142,857 |   | Total liabilities and equity | $257,142,857 |

 *b.* We can use the equation from the text to answer this question. The assets/sales and debt/sales are the percentages given in the problem, so:

 EFN =  × ΔSales –  × ΔSales – (PM × Projected sales) × (1 – *d*)

 EFN = (.20 + .70) × $34,285,714 – (.15 × $34,285,714) – [(.09 × $320,000,000) × (1 – .30)]

 EFN = $5,554,286

 *c.* The current assets, fixed assets, and short-term debt will all increase at the same percentage as sales. The long-term debt and common stock will remain constant. The accumulated retained earnings will increase by the addition to retained earnings for the year. We can calculate the addition to retained earnings for the year as:

 Net income = Profit margin × Sales

 Net income = .09($320,000,000)

 Net income = $28,800,000

 The addition to retained earnings for the year will be the net income times one minus the dividend payout ratio, which is:

 Addition to retained earnings = Net income(1 – *d*)

 Addition to retained earnings = $28,800,000(1 – .30)

 Addition to retained earnings = $20,160,000

 So, the new accumulated retained earnings will be:

 Accumulated retained earnings = $59,285,714 + 20,160,000

 Accumulated retained earnings = $79,445,714

 The pro forma balance sheet will be:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|   | Assets |   |   | Liabilities and equity |   |
|   | Current assets | $64,000,000 |   | Short-term debt | $48,000,000 |
|   |   |  |   | Long-term debt | $110,000,000 |
|   |   |  |   |   |  |
|   | Fixed assets | $224,000,000 |   | Common stock | $45,000,000 |
|   |   |  |   | Accumulated retained earnings | 79,445,714 |
|   |   |  |   | Total equity | $124,445,714 |
|   |   |  |   |   |  |
|   | Total assets | $288,000,000 |   | Total liabilities and equity | $282,445,714 |

 The EFN is:

 EFN = Total assets – Total liabilities and equity

 EFN = $288,000,000 – 282,445,714

 EFN = $5,554,286

**10.** *a.* The plowback ratio is one minus the dividend payout ratio, so:

 *b* = 1 – .25

 *b* = .75

 Now, we can use the sustainable growth rate equation to get:

 Sustainable growth rate = (ROE × *b*)/[1 – (ROE × *b*)]

 Sustainable growth rate = [.121(.75)]/[1 – .121(.75)]

 Sustainable growth rate = .0998, or 9.98%

 *b.* It is possible for the sustainable growth rate and the actual growth rate to differ. If any of the actual parameters in the sustainable growth rate equation differ from those used to compute the sustainable growth rate, the actual growth rate will differ from the sustainable growth rate. Since the sustainable growth rate includes ROE in the calculation, this also implies that changes in the profit margin, total asset turnover, or equity multiplier will affect the sustainable growth rate.

 *c*. The company can increase its growth rate by doing any of the following:

* Increase the debt-to-equity ratio by selling more debt or repurchasing stock.
* Increase the profit margin, most likely by better controlling costs.
* Decrease its total assets/sales ratio; in other words, utilize its assets more efficiently.
* Reduce the dividend payout ratio.

***CHAPTER 6***

**MAKING CAPITAL INVESTMENT DECISIONS**

**Answers to Concepts Review and Critical Thinking Questions**

**1.** In this context, an opportunity cost refers to the value of an asset or other input that will be used in a project. The relevant cost is what the asset or input is actually worth today, not, for example, what it cost to acquire it.

**2.** *a.* Yes, the reduction in the sales of the company’s other products, referred to as erosion, should be treated as an incremental cash flow. These lost sales are included because they are a cost (a revenue reduction) that the firm must bear if it chooses to produce the new product.

 *b.* Yes, expenditures on plant and equipment should be treated as incremental cash flows. These are costs of the new product line. However, if these expenditures have already occurred (and cannot be recaptured through a sale of the plant and equipment), they are sunk costs and are not included as incremental cash flows.

 *c.* No, the research and development costs should not be treated as incremental cash flows. The costs of research and development undertaken on the product during the past three years are sunk costs and should not be included in the evaluation of the project. Decisions made and costs incurred in the past cannot be changed. They should not affect the decision to accept or reject the project.

 *d.* Yes, the annual depreciation expense must be taken into account when calculating the cash flows related to a given project. While depreciation is not a cash expense that directly affects cash flow, it decreases a firm’s net income and hence lowers its tax bill for the year. Because of this depreciation tax shield, the firm has more cash on hand at the end of the year than it would have had without expensing depreciation.

 *e.* No, dividend payments should not be treated as incremental cash flows. A firm’s decision to pay or not pay dividends is independent of the decision to accept or reject any given investment project. For this reason, dividends are not an incremental cash flow to a given project. Dividend policy is discussed in more detail in later chapters.

 *f.* Yes, the resale value of plant and equipment at the end of a project’s life should be treated as an incremental cash flow. The price at which the firm sells the equipment is a cash inflow, and any difference between the book value of the equipment and its sale price will create accounting gains or losses that result in either a tax credit or liability.

 *g.* Yes, salary and medical costs for production employees hired for a project should be treated as incremental cash flows. The salaries of all personnel connected to the project must be included as costs of that project.

**3.** Item (a) is a relevant cost because the opportunity to sell the land is lost if the new golf club is produced. Item (b) is also relevant because the firm must take into account the erosion of sales of existing products when a new product is introduced. If the firm produces the new club, the earnings from the existing clubs will decrease, effectively creating a cost that must be included in the decision. Item (c) is irrelevant because the costs of research and development are sunk costs. Decisions made in the past cannot be changed. They are not relevant to the production of the new club.

**4.** For tax purposes, a firm would choose MACRS because it provides for larger depreciation deductions earlier. These larger deductions reduce taxes, but have no other cash consequences. Notice that the choice between MACRS and straight-line is purely a time value issue; the total depreciation is the same, only the timing differs.

**5.** It’s probably only a mild over-simplification. Current liabilities will all be paid, presumably. The cash portion of current assets will be retrieved. Some receivables won’t be collected, and some inventory will not be sold, of course. Counterbalancing these losses is the fact that inventory sold above cost (and not replaced at the end of the project’s life) acts to increase working capital. These effects tend to offset one another.

**6.** Management’s discretion to set the firm’s capital structure is applicable at the firm level. Since any one particular project could be financed entirely with equity, another project could be financed with debt, and the firm’s overall capital structure would remain unchanged. Financing costs are irrelevant in the analysis of a project’s incremental cash flows according to the stand-alone principle.

**7.** The EAC approach is appropriate when comparing mutually exclusive projects with different lives that will be replaced when they wear out. This type of analysis is necessary so that the projects have a common life span over which they can be compared. For example, if one project has a three-year life and the other has a five-year life, then a 15-year horizon is the minimum necessary to place the two projects on an equal footing, implying that one project will be repeated five times and the other will be repeated three times. Note the shortest common life may be quite long when there are more than two alternatives and/or when the individual project lives are relatively long. Assuming this type of analysis is valid implies that the project cash flows remain the same over the common life, thus ignoring the possible effects of, among other things: (1) inflation, (2) changing economic conditions, (3) the increasing unreliability of cash flow estimates that occur far into the future, and (4) the possible effects of future technology improvement that could alter the project cash flows.

**8.** Depreciation is a non-cash expense, but it is tax-deductible on the income statement. Thus depreciation causes taxes paid, an actual cash outflow, to be reduced by an amount equal to the depreciation tax shield, *Tc*D. A reduction in taxes that would otherwise be paid is the same thing as a cash inflow, so the effects of the depreciation tax shield must be added in to get the total incremental aftertax cash flows.

**9.** There are two particularly important considerations. The first is erosion. Will the “essentialized” book displace copies of the existing book that would have otherwise been sold? This is of special concern given the lower price. The second consideration is competition. Will other publishers step in and produce such a product? If so, then any erosion is much less relevant. A particular concern to book publishers (and producers of a variety of other product types) is that the publisher only makes money from the sale of new books. Thus, it is important to examine whether the new book would displace sales of used books (good from the publisher’s perspective) or new books (not good). The concern arises any time there is an active market for the used product.

**10.** Definitely. The damage to Porsche’s reputation is a factor the company needed to consider. If the reputation were to be damaged, the company would have lost sales of its existing car lines.

**11.** One company may be able to produce at lower incremental cost or market better. Also, of course, one of the two may have made a mistake!

**12.** Porsche would recognize that the outsized profits would dwindle as more products come to market and competition becomes more intense.

**Solutions to Questions and Problems**

*NOTE: All end-of-chapter problems were solved using a spreadsheet. Many problems require multiple steps. Due to space and readability constraints, when these intermediate steps are included in this solutions manual, rounding may appear to have occurred. However, the final answer for each problem is found without rounding during any step in the problem.*

 *Basic*

**1.** Using the tax shield approach to calculating OCF, we get:

 OCF = (Sales – Costs)(1 – *TC*) + *TC*Depreciation

 OCF = [($4.95 × 1,400) – ($1.97 × 1,400)](1 – .21) + .21($9,300/5)

 OCF = $3,686.48

 So, the NPV of the project is:

 NPV = –$9,300 + $3,686.48(PVIFA14%,5)

 NPV = $3,355.98

**2.** We will use the bottom-up approach to calculate the operating cash flow for each year. We also must be sure to include the net working capital cash flows each year. So, the net income and total cash flow each year will be:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  |  | Year 1 | Year 2 | Year 3 | Year 4 |
|  | Sales |  |  $13,400  |  $15,000  |  $16,400  |  $12,900  |
|   | Costs |  |  2,900  |  3,100  |  4,200  |  2,800  |
|   | Depreciation |  |  6,575  |  6,575  |  6,575  |  6,575  |
|   | EBT |  |  $3,925  |  $5,325  |  $5,625  |  $3,525  |
|   | Tax |  | 864 | 1,172 | 1,238 | 776 |
|   | Net income |  | $3,062 | $4,154 | $4,388 | $2,750 |
|   |   |  |  |  |  |  |
|   | OCF |  | $9,637 | $10,729 | $10,963 | $9,325 |
|   | Capital spending | –$26,300 |  |  |  |  |
|   | NWC | –300 | –200 | –225 | –150 | 875 |
|   | Incremental cash flow | –$26,600 | $9,437 | $10,504 | $10,813 | $10,200 |

 The NPV for the project is:

 NPV = –$26,600 + $9,437/1.12 + $10,504/1.122 + $10,813/1.123 + $10,200/1.124

 NPV = $4,376.86

**3.**  Using the tax shield approach to calculating OCF, we get:

 OCF = (Sales – Costs)(1 – *T*C) + *T*CDepreciation

 OCF = ($1,090,000 – 475,000)(1 – .25) + .25($1,420,000/3)

 OCF = $579,583.33

 So, the NPV of the project is:

 NPV = –$1,420,000 + $579,583.33(PVIFA12%,3)

 NPV = –$27,938.63

**4.** The cash outflow at the beginning of the project will increase because of the spending on NWC. At the end of the project, the company will recover the NWC, so it will be a cash inflow. The sale of the equipment will result in a cash inflow, but we also must account for the taxes which will be paid on this sale. So, the cash flows for each year of the project will be:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Year | Cash Flow |  |  |
|  | 0 | – $1,670,000 |  |  = –$1,420,000 – 250,000 |
|  | 1 | 579,583.33 |  |  |
|  | 2 | 579,583.33 |  |  |
|  | 3 | 1,002,083.33 |  |  = $579,583.33 + 250,000 + 230,000 + (0 – 230,000)(.25) |

 And the NPV of the project is:

 NPV = –$1,670,000 + $579,583.33(PVIFA12%,2) + ($1,002,083.33/1.123)

 NPV = $22,788.53

**5.** First, we will calculate the annual depreciation for the equipment necessary for the project. The depreciation amount each year will be:

 Year 1 depreciation = $1,420,000(.3333) = $473,286

 Year 2 depreciation = $1,420,000(.4445) = $631,190

 Year 3 depreciation = $1,420,000(.1481) = $210,302

 So, the book value of the equipment at the end of three years, which will be the initial investment minus the accumulated depreciation, is:

 Book value in 3 years = $1,420,000 – ($473,286 + 631,190 + 210,302)

 Book value in 3 years = $105,222

 The asset is sold at a gain to book value, so this gain is taxable.

 Aftertax salvage value = $230,000 + ($105,222 – 230,000)(.25)

 Aftertax salvage value = $198,805.50

 To calculate the OCF, we will use the tax shield approach, so the cash flow each year is:

 OCF = (Sales – Costs)(1 – *TC*) + *TC*Depreciation

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Year | Cash Flow |  |  |
|  | 0 | – $1,670,000 |  |  = –$1,420,000 – 250,000 |
|  | 1 | 579,571.50 |  |  = ($615,000)(.75) + .25($473,286) |
|  | 2 | 619,047.50 |  |  = ($615,000)(.75) + .25($631,190) |
|  | 3 | 962,631.00 |  |  = ($615,000)(.75) + .25($210,302) + $198,805.50 + 250,000 |

 Remember to include the NWC cost in Year 0, and the recovery of the NWC at the end of the project. The NPV of the project with these assumptions is:

 NPV = –$1,670,000 + $579,571.50/1.12 + $619,047.50/1.122 + $962,631.00/1.123

 NPV = $26,157.16

**6.** The book value of the asset is zero, so the gain on the sale is taxable.

 Aftertax salvage value = $230,000 + ($0 – 230,000)(.25)

 Aftertax salvage value = $172,500

 To calculate the OCF, we will use the tax shield approach, so the cash flow each year is:

 OCF = (Sales – Costs)(1 – *TC*) + *TC*Depreciation

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Year | Cash Flow |  |  |
|  | 0 | – $1,670,000 |  |  = –$1,420,000 – 250,000 |
|  | 1 | 816,250 |  |  = ($615,000)(.75) + .25($1,420,000) |
|  | 2 | 461,250 |  |  = ($615,000)(.75)  |
|  | 3 | 883,750 |  |  = ($615,000)(.75) + $172,500 + 250,000 |

 Remember to include the NWC cost in Year 0, and the recovery of the NWC at the end of the project. The NPV of the project with these assumptions is:

 NPV = –$1,670,000 + $816,250/1.12 + $461,250/1.122 + $883,750/1.123

 NPV = $55,536.11

**7.** First, we will calculate the annual depreciation of the new equipment. It will be:

 Annual depreciation charge = $575,000/5

 Annual depreciation charge = $115,000

 The aftertax salvage value of the equipment is:

 Aftertax salvage value = $60,000(1 – .23)

 Aftertax salvage value = $46,200

 Using the tax shield approach, the OCF is:

 OCF = $176,000(1 – .23) + .23($115,000)

 OCF = $161,970

 Now we can find the project IRR. There is an unusual feature that is a part of this project. Accepting this project means that we will reduce NWC. This reduction in NWC is a cash inflow at Year 0. This reduction in NWC implies that when the project ends, we will have to increase NWC. So, at the end of the project, we will have a cash outflow to restore the NWC to its level before the project. We also must include the aftertax salvage value at the end of the project. The IRR of the project is:

 NPV = 0 = –$575,000 + 80,000 + $161,970(PVIFAIRR%,4)

 + [($161,970 + 46,200 – 80,000)/(1+ IRR)5]

 IRR = 17.70%

**8.** First, we will calculate the annual depreciation of the new equipment. It will be:

 Annual depreciation = $375,000/5

 Annual depreciation = $75,000

 Now, we calculate the aftertax salvage value. The aftertax salvage value is the market price minus (or plus) the taxes on the sale of the equipment, so:

 Aftertax salvage value = MV + (BV – MV)*TC*

 Very often, the book value of the equipment is zero as it is in this case. If the book value is zero, the equation for the aftertax salvage value becomes:

 Aftertax salvage value = MV + (0 – MV)*TC*

 Aftertax salvage value = MV(1 – *TC*)

 We will use this equation to find the aftertax salvage value since we know the book value is zero. So, the aftertax salvage value is:

 Aftertax salvage value = $25,000(1 – .24)

 Aftertax salvage value = $19,000

 Using the tax shield approach, we find the OCF for the project is:

 OCF = $95,000(1 – .24) + .24($75.000)

 OCF = $90,200

 Now we can find the project NPV. Notice that we include the NWC in the initial cash outlay. The recovery of the NWC occurs in Year 5, along with the aftertax salvage value.

 NPV = –$375,000 – 15,000 + $90,200(PVIFA10%,5) + ($19,000 + 15,000)/1.105

 NPV = –$26,959.71

**9.** The book value of the asset will be zero at the end of the project, so the aftertax salvage value is:

 Aftertax salvage value = $25,000(1 – .24)

 Aftertax salvage value = $19,000

 Using the tax shield approach, we find the OCF for the first year of the project is:

 OCF = $95,000(1 – .24) + .24($375,000)

 OCF = $162,200

 And the OCF for Years 2 to 5 is:

 OCF = $95,000(1 – .24)

 OCF = $72,200

 Now we can find the project NPV. Notice that we include the NWC in the initial cash outlay. The recovery of the NWC occurs in Year 5, along with the aftertax salvage value.

 NPV = –$375,000 – 15,000 + $162,200/1.10 + $72,200/1.102 + $72,200/1.103 + $72,200/1.104

+ ($72,200 + 19,000 + 15,000)/1.105

 NPV = –$13,375.69

**10.** To find the book value at the end of four years, we need to find the accumulated depreciation for the first four years. We could calculate a table with the depreciation each year, but an easier way is to add the MACRS depreciation amounts for each of the first four years and multiply this percentage times the cost of the asset. We can then subtract this from the asset cost. Doing so, we get:

 BV4 = $7,600,000 – 7,600,000(.2000 + .3200 + .1920 + .1152)

 BV4 = $1,313,280

 The asset is sold at a gain to book value, so this gain is taxable.

 Aftertax salvage value = $1,400,000 + ($1,313,280 – 1,400,000)(.21)

 Aftertax salvage value = $1,381,789

**11.** We will begin by calculating the initial cash outlay, that is, the cash flow at Time 0. To undertake the project, we will have to purchase the equipment and increase net working capital. So, the cash outlay today for the project will be:

|  |  |  |
| --- | --- | --- |
|   | Equipment | –$4,100,000 |
|   | NWC |  –150,000 |
|   | Total | –$4,250,000 |

Using the bottom-up approach to calculating the operating cash flow, we find the operating cash flow each year will be:

|  |  |  |
| --- | --- | --- |
|   | Sales | $2,350,000 |
|   | Costs | 587,500 |
|   | Depreciation | 1,025,000 |
|   | EBT | $737,500 |
|   | Tax | 184,375 |
|   | Net income | $553,125 |

 The operating cash flow is:

 OCF = Net income + Depreciation

 OCF = $553,125 + 1,025,000

 OCF = $1,578,125

 To find the NPV of the project, we add the present value of the project cash flows. We must be sure to add back the net working capital at the end of the project life, since we are assuming the net working capital will be recovered. So, the project NPV is:

 NPV = –$4,250,000 + $1,578,125(PVIFA13%,4) + $150,000/1.134

 NPV = $536,085.37

**12.** We will need the aftertax salvage value of the equipment to compute the EAC. Even though the equipment for each product has a different initial cost, both have the same salvage value. The aftertax salvage value for both is:

 Aftertax salvage value = $25,000(1 – .21)

 Aftertax salvage value = $19,750

 To calculate the EAC, we first need the OCF and PV of costs of each option. The OCF and PV of costs for Techron I is:

 OCF = –$41,000(1 – .21) + .21($265,000/3)

 OCF = –$13,840

 PV of costs = –$265,000 + –$13,840(PVIFA9%,3) + ($19,750/1.093)

 PV of costs = –$284,782.49

 EAC = –$284,782.49/(PVIFA9%,3)

 EAC = –$112,504.68

 And the OCF and PV of costs for Techron II is:

 OCF = – $52,000(1 – .21) + .21($330,000/5)

 OCF = –$27,220

 PV of costs = –$330,000 – $27,220(PVIFA9%,5) + ($19,750/1.095)

 PV of costs = –$423,040.16

 EAC = –$423,040.16/(PVIFA9%,5)

 EAC = –$108,760.43

 The two milling machines have unequal lives, so they can only be compared by expressing both on an equivalent annual basis, which is what the EAC method does. Thus, you prefer the Techron II because it has the lower (less negative) annual cost.

  *Intermediate*

**13.** First, we will calculate the depreciation each year, which will be:

 D1 = $670,000(.2000) = $134,000

 D2 = $670,000(.3200) = $214,400

 D3 = $670,000(.1920) = $128,640

 D4 = $670,000(.1152) = $77,184

 The book value of the equipment at the end of the project is:

 BV4 = $670,000 – ($134,000 + 214,400 + 128,640 + 77,184)

 BV4 = $115,776

 The asset is sold at a loss to book value, so this creates a tax refund. The aftertax salvage value will be:

 Aftertax salvage value = $55,000 + ($115,776 – 55,000)(.23)

 Aftertax salvage value = $68,978.48

 So, the OCF for each year will be:

 OCF1 = $245,000(1 – .23) + .23($134,000) = $219,470.00

 OCF2 = $245,000(1 – .23) + .23($214,400) = $237,962.00

 OCF3 = $245,000(1 – .23) + .23($128,640) = $218,237.20

 OCF4 = $245,000(1 – .23) + .23($77,184) = $206,402.32

 Now we have all the necessary information to calculate the project NPV. We need to be careful with the NWC in this project. Notice the project requires $20,000 of NWC at the beginning, and $2,500 more in NWC each successive year. We will subtract the $20,000 from the initial cash flow and subtract $2,500 each year from the OCF to account for this spending. In Year 4, we will add back the total spent on NWC, which is $27,500. The $2,500 spent on NWC capital during Year 4 is irrelevant. Why? Well, during this year the project required an additional $2,500, but we would get the money back immediately. So, the net cash flow for additional NWC would be zero. With all this, the equation for the NPV of the project is:

 NPV = –$670,000 – 20,000 + ($219,470 – 2,500)/1.08 + ($237,962 – 2,500)/1.082

 + ($218,237.20 – 2,500)/1.083 + ($206,402.32 + 27,500 + 68,978.48)/1.084

 NPV = $106,654.44

**14.** The book value of the asset is zero, so the aftertax salvage value will be:

 Aftertax salvage value = $55,000 + ($0 – 55,000)(.23)

 Aftertax salvage value = $42,350

 So, the OCF for each year will be:

 OCF1 = $245,000(1 – .23) + .23($670,000) = $342,750

 OCF2 = $245,000(1 – .23) = $188,650

 OCF3 = $245,000(1 – .23) = $188,650

 OCF4 = $245,000(1 – .23) = $188,650

 Now we have all the necessary information to calculate the project NPV. We need to be careful with the NWC in this project. Notice the project requires $20,000 of NWC at the beginning, and $2,500 more in NWC each successive year. We will subtract the $20,000 from the initial cash flow and subtract $2,500 each year from the OCF to account for this spending. In Year 4, we will add back the total spent on NWC, which is $27,500. The $2,500 spent on NWC capital during Year 4 is irrelevant. Why? Well, during this year the project required an additional $2,500, but we would get the money back immediately. So, the net cash flow for additional NWC would be zero. With all this, the equation for the NPV of the project is:

 NPV = –$675,000 – 20,000 + ($342,750 – 2,500)/1.08 + ($188,650 – 2,500)/1.082

 + ($188,650 – 2,500)/1.083 + ($188,650 + 27,500 + 42,350)/1.084

 NPV = $122,417.01