

Chapter 8: Risk Analysis, Real Options, and Capital Budgeting

- 8.1 Calculate the NPV of the expected payoff for the option of going directly to market.

$$\begin{aligned}\text{NPV}(\text{Go Directly}) &= C_{\text{Success}} (\text{Prob. of Success}) + C_{\text{Failure}} (\text{Prob. of Failure}) \\ &= \$20,000,000 (0.50) + \$5,000,000 (0.50) \\ &= \$12,500,000\end{aligned}$$

The expected payoff of going directly to market is \$12,500,000.

The test marketing requires a \$2 million cash outlay. Choosing the test marketing option will also delay the launch of the product by one year. Thus, the expected payoff is delayed by one year and must be discounted back to year 0.

$$\begin{aligned}\text{NPV}(\text{Test Market}) &= -C_0 + [C_{\text{Success}} (\text{Prob. of Success})] / (1+r)^T + \\ &\quad [C_{\text{Failure}} (\text{Prob. of Failure})] / (1+r)^T \\ &= -\$2,000,000 + [\$20,000,000 (0.75)] / (1.15) + \\ &\quad [\$5,000,000 (0.25)] / (1.15) \\ &= \$12,130,434.78\end{aligned}$$

The expected payoff of test marketing the product is \$12,130,434.78.

Sony should go directly to market with the product since that option has the highest expected payoff.

- 8.2 Calculate the NPV of each option. The manager should pursue the option with the highest NPV.

$$\begin{aligned}\text{NPV}(\text{Go Directly}) &= C_{\text{Success}} (\text{Prob. of Success}) \\ &= \$1,200,000 (0.50) \\ &= \$600,000\end{aligned}$$

The NPV of going directly to market is \$600,000.

$$\begin{aligned}\text{NPV}(\text{Focus Group}) &= C_0 + C_{\text{Success}} (\text{Prob. of Success}) \\ &= -\$120,000 + \$1,200,000 (0.70) \\ &= \$720,000\end{aligned}$$

The NPV when conducting a focus group is \$720,000.

$$\begin{aligned}\text{NPV}(\text{Consulting Firm}) &= C_0 + C_{\text{Success}} (\text{Prob. of Success}) \\ &= -\$400,000 + \$1,200,000 (0.90) \\ &= \$680,000\end{aligned}$$

The NPV when hiring a consulting firm is \$680,000.

The firm should conduct a focus group since that option has the highest NPV.

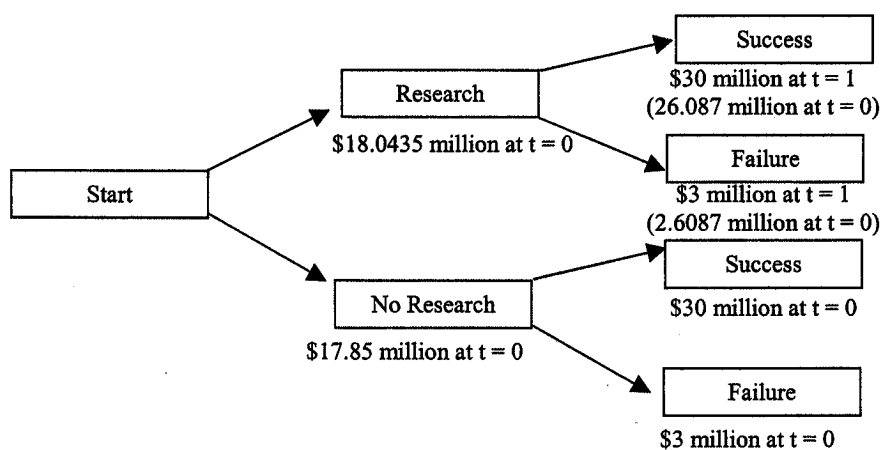
8.3 Recommend the strategy that has the highest NPV.

$$\begin{aligned}
 \text{NPV(Lower Prices)} &= C_{\text{Success}} (\text{Prob. of Success}) + C_{\text{Failure}} (\text{Prob. of Failure}) \\
 &= -\$1,300,000 (0.55) - \$1,850,000 (0.45) \\
 &= -\$1,547,500
 \end{aligned}$$

$$\begin{aligned}
 \text{NPV(Lobbyist)} &= C_0 + C_{\text{Success}} (\text{Prob. of Success}) + C_{\text{Failure}} (\text{Prob. of Failure}) \\
 &= -\$800,000 - \$0 (0.75) - \$2,000,000 (0.25) \\
 &= -\$1,300,000
 \end{aligned}$$

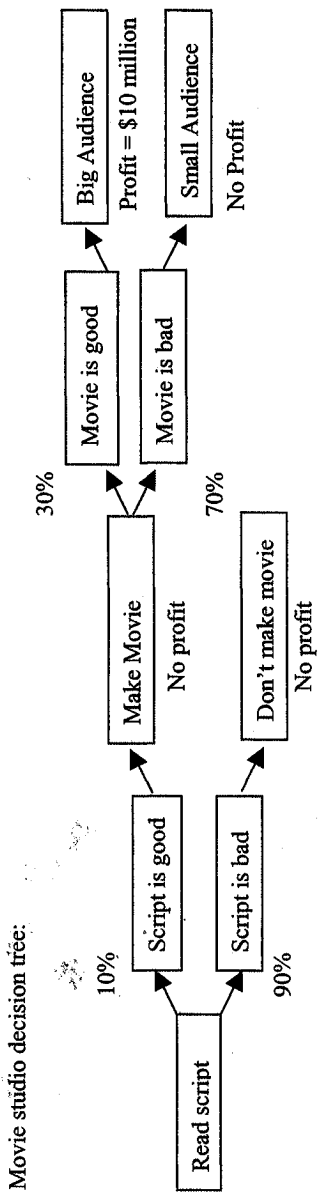
The CFO should hire the lobbyist since that option has the highest NPV.

8.4 Since the NPV of Research is greater than that of no research, based on expected outcomes, B&B should go directly to market.



Note: Research = -1 million investment + 0.7 * (26.087) if successful + 0.3 * (2.6087) if unsuccessful
 No Research = 0.55 * (30) if successful + 0.45 * (3) if unsuccessful

8.5. Carl should have taken the \$5,000.
 Expected return for 1% of movie profits is \$3,000. Since only good scripts are made into movies and only a good movie would make a profit: $(10\% \times 30\% \times \$10 \text{ mil} \times 1\%)$



- 8.6 Apply the *accounting profit break-even point* (BEP) formula and solve for the sales price, x , that allows the firm to break even when producing 20,000 calculators. In order for the firm to break even, the revenues from the calculator sales (number of calculators sold \times sales price per unit) must equal the total annual cost of producing the calculators. Remember to include taxes in the analysis.

Variable costs = \$15 per calculator

Fixed costs = \$900,000 per year

Depreciation = (Initial Investment / Economic Life)
 = (\$600,000 / 5)
 = \$120,000 per year

Divide the after-tax sum of the depreciation expense and the fixed costs by the calculator's after-tax contribution margin (selling price, x , minus variable cost). The after-tax contribution margin is the amount that each additional calculator contributes to the firm's profit. Before the firm can realize a positive profit, it must have earned enough to cover its fixed costs and depreciation expense. Solve for x .

$$\begin{aligned} \frac{[(\text{Fixed Costs} + \text{Depr.}) (1 - T_c)]}{x} &= \frac{[(\text{Sales Price} - \text{Variable Cost}) (1 - T_c)]}{x} = \text{BEP} \\ \frac{[(\$900,000 + \$120,000) (1 - 0.30)]}{x} &= \frac{[(x - \$150) (1 - 0.30)]}{x} = 20,000 \\ x &= \$66 \end{aligned}$$

The break-even sales price of the calculator is \$66.

- 8.7 Apply the *accounting profit break-even point* formula. Divide the after-tax sum of the annual depreciation expense and the annual fixed costs by the television's after-tax contribution margin (selling price minus variable cost).

$$\begin{aligned} \frac{[(\text{Fixed Costs} + \text{Depr.}) (1 - T_c)]}{x} &= \frac{[(\text{Sales Price} - \text{Variable Cost}) (1 - T_c)]}{x} = \text{BEP} \\ \frac{[(\$120,000 + \$20,000) (1 - 0.35)]}{x} &= \frac{[(\$1,500 - \$1,100) (1 - 0.35)]}{x} = 350 \end{aligned}$$

The distributor must sell 350 televisions per year to break even.

- 8.8 a. Apply the *accounting profit break-even point* formula. Divide the after-tax sum of the fixed costs and depreciation charge by the abalone's after-tax contribution margin (selling price minus variable cost). The number of abalones that the proprietor must sell in order for you to receive any profit is the break-even point (BEP).

$$\begin{aligned} \frac{[(\text{Fixed Costs} + \text{Depr.}) (1 - T_c)]}{x} &= \frac{[(\text{Sales Price} - \text{Variable Cost}) (1 - T_c)]}{x} = \text{BEP} \\ \frac{[(\$340,000 + \$20,000) (1 - 0.35)]}{x} &= \frac{[(\$2.00 - \$0.72) (1 - 0.35)]}{x} \\ x &= 281,250 \end{aligned}$$

The proprietor must sell at least 281,250 abalones per year in order for you to receive any profit.

- b. To calculate the amount of profit you will receive if the proprietor sells 300,000 abalones, subtract the total cost incurred from the total revenue received. Remember to include taxes.

$$\begin{aligned} \text{Total Revenue Per Year} &= (\text{Sales Price}) (\text{Number Sold}) (1 - T_c) \\ &= (\$2.00) (300,000) (1 - 0.35) \\ &= \$390,000 \end{aligned}$$

$$\begin{aligned}
 \text{Total Cost Per Year} &= [\text{Fixed Cost} + \text{Depr.} + (\text{Variable Cost}) (\text{Number Sold})] (1 - T_c) \\
 &= [\$340,000 + \$20,000 + (\$0.72) (300,000)] (1 - 0.35) \\
 &= \$374,400
 \end{aligned}$$

$$\begin{aligned}
 \text{Total Profit} &= \text{Total Revenue} - \text{Total Cost} \\
 &= \$390,000 - \$374,400 \\
 &= \$15,600
 \end{aligned}$$

You will receive \$15,600 if the proprietor sells 300,000 abalones.

8.9 Played $2187.5 = \text{CEILING} ((1000 + 50)/(0.5 - 0.02), 1)$

8.10 a) $\frac{(\text{Fixed Cost} + \text{Depreciation}) \times (1 - T_c)}{(\text{Sales price} - \text{Variable cost}) \times (1 - T_c)} = \frac{(0 + 2,000) \times (1 - .3)}{(10 - 8) \times (1 - .3)} = 1000 \text{ T-shirts}$

b) $\frac{(\text{EAC} + \text{Fixed cost}) \times (1 - T_c) + \text{Depreciation} \times (T_c)}{(\text{Sales price} - \text{Variable cost}) \times (1 - T_c)} = \frac{(10,000 / 2.4018) + 0 + 0}{(10 - 8) \times (1 - .3)} = 2974 \text{ T-shirts}$

8.11 When calculating the present value break-even point, express the initial investment of \$140,000 as an equivalent annual cost (EAC). Divide the initial investment by the seven-year annuity factor, discounted at 15 percent. The EAC incorporates the opportunity cost of the investment.

$$\begin{aligned}
 \text{EAC} &= \text{Initial Investment} / A^T_r \\
 &= \$140,000 / A^{7}_{0.15} \\
 &= \$33,650.45
 \end{aligned}$$

Calculate the annual depreciation expense.

$$\begin{aligned}
 \text{Depreciation} &= \$140,000 / 7 \\
 &= \$20,000
 \end{aligned}$$

Calculate the present-value break-even point. The fixed costs are \$340,000. Remember to incorporate taxes into the calculation. Remember to include the depreciation tax shield, which lowers the firm's tax bill.

$$\begin{aligned}
 &[\text{EAC} + (\text{Annual Fixed Costs}) (1 - T_c) - (\text{Annual Depr.}) (T_c)] / [(\text{Sales Price} - \text{Variable Cost}) (1 - T_c)] \\
 &= \text{BEP}
 \end{aligned}$$

$$\begin{aligned}
 &[\$33,650.45 + \$340,000 (0.65) - \$20,000 (0.35)] / [(\$2 - \$0.72) (0.65)] = 297,656.79 \\
 &\cong 297,657 \text{ units}
 \end{aligned}$$

The present value break-even point is 297,657 abalones.

- 8.12 When calculating the present value break-even point, express the initial investment of \$200,000 as an equivalent annual cost (EAC). Divide the initial investment by the five-year annuity factor, discounted at 12 percent.

$$\begin{aligned} \text{EAC} &= \text{Initial Investment} / A^T_r \\ &= \$200,000 / A^{5}_{0.12} \\ &= \$55,481.95 \end{aligned}$$

Calculate the annual depreciation expense.

$$\begin{aligned} \text{Depreciation} &= \$200,000 / 5 \\ &= \$40,000 \end{aligned}$$

Calculate the present-value break-even point.

$$\begin{aligned} &[\text{EAC} + (\text{Fixed Costs}) (1 - T_c) - (\text{Depr.}) (T_c)] / [(\text{Sales Price} - \text{Variable Cost}) (1 - T_c)] \\ &= \text{BEP} \\ &[\$55,481.95 + (\$350,000) (0.75) - (\$40,000) (0.25)] / [(\$25 - \$5) (0.75)] = \mathbf{20,532.13} \end{aligned}$$

The present value break-even point is 20,532 units.

- 8.13 *The following represents a different approach to solving present-value break-even problems, unlike the EAC method used in problems 8.8 and 8.7. Both the EAC approach and this approach will yield the same answer.*

First, determine the cash flow from selling the old harvester. When calculating the salvage value, remember that tax liabilities or credits are generated on the *difference* between the resale value and the book value of the asset.

Use the original purchase price of the old harvester to determine annual depreciation.

$$\begin{aligned} \text{Depreciation Per Period} &= \$45,000 / 15 \\ &= \$3,000 \end{aligned}$$

Since the machine is five years old, the firm has accumulated five annual depreciation charges, reducing the book value of the machine. The current book value of the machine is equal to the initial purchase price minus the accumulated depreciation.

$$\begin{aligned} \text{Book Value} &= \text{Initial Purchase Price} - \text{Accumulated Depreciation} \\ &= \$45,000 - (\$3,000 \times 5 \text{ years}) \\ &= \$30,000 \end{aligned}$$

Since the firm is able to resell the old harvester for \$20,000, which is less than the \$30,000 book value of the machine, the firm will generate a tax credit on the sale.

$$\begin{aligned} \text{PV(Resale Value)} &= C - T_c (\text{Resale Value} - \text{Book Value}) \\ &= \$20,000 - 0.34 (\$20,000 - \$30,000) \\ &= \$23,400 \end{aligned}$$

Calculate the incremental depreciation. Calculate the depreciation tax shield generated by the new harvester less the forgone depreciation tax shield from the old harvester. Let P be the break-even purchase price.

$$\begin{aligned} \text{Depreciation Tax Shield, New Harvester} &= (\text{Initial Investment} / \text{Economic Life}) \times T_c \\ &= (P / 10) (0.34) \end{aligned}$$

$$\begin{aligned} \text{Depreciation Tax Shield, Old Harvester} &= (\$45,000 / 15) (0.34) \\ &= (\$3,000) (0.34) \end{aligned}$$

$$\text{Incremental Depreciation Tax Shield} = (P / 10 - \$3,000) (0.34)$$

Apply the 10-year annuity formula, discounted at 15 percent, to calculate the PV of the incremental depreciation tax shield.

$$\text{PV(Depreciation Tax Shield)} = (P / 10 - \$3,000) (0.34) A_{0.15}^{10}$$

The new harvester will generate year-end pre-tax cash flow savings of \$10,000 per year for 10 years. Apply the 10-year annuity formula, discounted at 15 percent, to find the PV of those savings. Remember to include taxes.

$$\begin{aligned} \text{PV(Savings)} &= (1 - T_c) C_1 A_r^T \\ &= (1 - 0.34) \$10,000 A_{0.15}^{10} \\ &= \$33,123.87 \end{aligned}$$

The break-even purchase price of the new harvester is the price, P , which makes the NPV of the machine equal to zero.

$$\begin{aligned} \text{NPV} &= -P + \text{PV(Resale Value)} + \text{PV(Depreciation Tax Shield)} + \text{PV(Savings)} \\ \$0 &= -P + \$23,400 + (P / 10 - \$3,000) (0.34) A_{0.15}^{10} + \$33,123.87 \\ P &= \$61,981.06 \end{aligned}$$

The break-even purchase price is \$61,981.06.

8.14	A 5,0.08	3,993
	EAC	75,136,936
	Depreciation	60,000

	PV	
	Break-Even	3,518

8.15 a. Pessimistic:

Calculate the NPV of the pessimistic scenario. First, determine the yearly cash flow.

$$\begin{aligned} \text{Cash Flow} &= [\text{Revenue} - \text{Variable Costs} - \text{Fixed Costs}] (1 - T_c) + \text{Depr. Tax Shield} \\ &= [(\$38 \times 23,000) - (\$21 \times 23,000) - \$320,000] (1 - 0.35) + \\ &\quad (\$420,000 / 7) (0.35) \\ &= \$67,150 \end{aligned}$$

Apply the seven-year annuity formula to calculate the NPV of the machine. Subtract the initial investment.

$$\begin{aligned} \text{NPV} &= C_0 + C_1 A_r^T \\ &= -\$420,000 + \$67,150 A_{0.13}^7 \\ &= -\$123,021.71 \end{aligned}$$

The NPV of the pessimistic scenario is -\$123,021.71.

Expected:

Calculate the NPV of the expected scenario. First, determine the yearly cash flow.

$$\begin{aligned}
\text{Cash Flow} &= [\text{Revenue} - \text{Variable Costs} - \text{Fixed Costs}] (1 - T_c) + \text{Depr. Tax Shield} \\
&= [(\$40 \times 25,000) - (\$20 \times 25,000) - \$300,000] (1 - 0.35) \\
&\quad + (\$420,000 / 7) (0.35) \\
&= \$151,000
\end{aligned}$$

Apply the seven-year annuity formula to calculate the NPV of the machine. Subtract the initial investment.

$$\begin{aligned}
\text{NPV} &= C_0 + C_1 A_r^T \\
&= -\$420,000 + \$151,000 A_{0.13}^7 \\
&= \$247,814.18
\end{aligned}$$

The NPV of the expected scenario is \$247,814.18.

Optimistic:

Calculate the NPV of the optimistic scenario. First, determine the yearly cash flow.

$$\begin{aligned}
\text{Cash Flow} &= [\text{Revenue} - \text{Variable Costs} - \text{Fixed Costs}] (1 - T_c) \\
&\quad + \text{Depreciation Tax Shield} \\
&= [(\$42 \times 27,000) - (\$19 \times 27,000) - \$280,000] (1 - 0.35) \\
&\quad + (\$420,000 / 7) (0.35) \\
&= \$242,650
\end{aligned}$$

Apply the seven-year annuity formula to calculate the NPV of the machine. Subtract the initial investment.

$$\begin{aligned}
\text{NPV} &= C_0 + C_1 A_r^T \\
&= -\$420,000 + \$242,650 A_{0.13}^7 \\
&= \$653,146.42
\end{aligned}$$

The NPV of the optimistic scenario is \$653,146.42.

- b. Calculate the expected NPV of the project to form your conclusion about the project. Remember that, since each scenario is equally likely, the expected NPV is the average of the three scenarios.

$$\begin{aligned}
\text{NPV} &= [\text{NPV}(\text{Pessimistic}) + \text{NPV}(\text{Expected}) + \text{NPV}(\text{Optimistic})] / (3) \\
&= [-\$123,021.71 + \$247,814.18 + \$653,146.42] / 3 \\
&= \$259,312.96
\end{aligned}$$

The expected NPV of the project is \$259,312.96. You should conclude that the project is worthwhile.

8.16 Pessimistic:

Calculate the NPV of the pessimistic scenario. First, determine the yearly cash flow. To determine the number of rackets sold, multiply the market size by the market share.

$$\begin{aligned}\text{Number of Rackets} &= \text{Market Size} \times \text{Market Share} \\ &= 110,000 \times 0.22 \\ &= 24,200\end{aligned}$$

$$\begin{aligned}\text{Cash Flow} &= [\text{Revenue} - \text{Variable Costs} - \text{Fixed Costs}] (1 - T_c) \\ &\quad + \text{Depreciation Tax Shield} \\ &= [\$115 \times 24,200 - \$72 \times 24,200 - \$850,000] (1 - 0.4) \\ &\quad + (\$1,500,000 / 5) (0.4) \\ &= \$234,360\end{aligned}$$

Apply the five-year annuity formula to calculate the NPV of the racket project. Subtract the initial investment.

$$\begin{aligned}\text{NPV} &= C_0 + C_1 A_r^T \\ &= -\$1,500,000 + \$234,360 A_{0.13}^5 \\ &= -\$675,701.68\end{aligned}$$

Expected:

Calculate the NPV of the expected scenario. First, determine the yearly cash flow. To determine the number of rackets sold, multiply the market size by the market share.

$$\begin{aligned}\text{Number of Rackets} &= \text{Market Size} \times \text{Market Share} \\ &= 120,000 \times 0.25 \\ &= 30,000\end{aligned}$$

$$\begin{aligned}\text{Cash Flow} &= [\text{Revenue} - \text{Variable Costs} - \text{Fixed Costs}] (1 - T_c) \\ &\quad + \text{Depreciation Tax Shield} \\ &= [\$120 \times 30,000 - \$70 \times 30,000 - \$800,000] (1 - 0.4) \\ &\quad + (\$1,500,000 / 5) (0.4) \\ &= \$540,000\end{aligned}$$

Apply the five-year annuity formula to calculate the NPV of the racket project. Subtract the initial investment.

$$\begin{aligned}\text{NPV} &= C_0 + C_1 A_r^T \\ &= -\$1,500,000 + \$540,000 A_{0.13}^5 \\ &= \$399,304.88\end{aligned}$$

Optimistic:

Calculate the NPV of the optimistic scenario. First, determine the yearly cash flow. To determine the number of rackets sold, multiply the market size by the market share.

$$\begin{aligned} \text{Number of Rackets} &= \text{Market Size} \times \text{Market Share} \\ &= 130,000 \times 0.27 \\ &= 35,100 \end{aligned}$$

$$\begin{aligned} \text{Cash Flow} &= [\text{Revenue} - \text{Variable Costs} - \text{Fixed Costs}] (1 - T_c) \\ &\quad + \text{Depreciation Tax Shield} \\ &= [\$125 \times 35,100 - \$68 \times 35,100 - \$750,000] (1 - 0.4) \\ &\quad + (\$1,500,000 / 5) (0.4) \\ &= \$870,420 \end{aligned}$$

Apply the five-year annuity formula to calculate the NPV of the racket project. Subtract the initial investment.

$$\begin{aligned} \text{NPV} &= C_0 + C_1 A^T_r \\ &= -\$1,500,000 + \$870,420 A^{5}_{0.13} \\ &= \$1,561,468.43 \end{aligned}$$

Calculate the expected NPV of the project. Since each scenario is equally likely, the expected NPV is the average of the three scenarios.

$$\begin{aligned} \text{NPV} &= [\text{NPV(Pessimistic)} + \text{NPV(Expected)} + \text{NPV(Optimistic)}] / (3) \\ &= [-\$675,701.68 + \$399,304.88 + \$1,561,468.43] / (3) \\ &= \$428,357.21 \end{aligned}$$

The expected NPV of the project is \$428,357.21. You should accept the project.

8.17 Holding all variables as expected, except a single sensitivity analysis variable that is held at pessimistic or optimistic.

NPV	Pessimistic	Optimistic
Market Size	\$1,318,066	4,132,725
Market Share	\$1,880,998	3,569,793
Price	\$848,956	4,601,835
Variable Cost	\$2,256,286	3,194,506
Fixed Cost	\$2,600,300	2,850,492
NPV	Expected	
	\$2,725,396	

Since under all scenarios NPVs come out positive, the project should be taken.

Expected

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	NPV
<i>Investments:</i>							
Touch screen system	\$(150,000)						
Annual maintenance		\$(5,000)	\$(5,000)	\$(5,000)	\$(5,000)	\$(5,000)	
Change in NWC		\$(5,000)				\$ 5,000	
Wages saved		\$30,000	\$30,000	\$30,000	\$30,000	\$30,000	
Total cash flow from investments	\$ (150,000)	\$20,000	\$25,000	\$25,000	\$25,000	\$30,000	
<i>Income:</i>							
Revenue		\$15,000	\$15,000	\$15,000	\$15,000	\$15,000	
COGS		\$(3,750)	\$(3,750)	\$(3,750)	\$(3,750)	\$(3,750)	
Cash flow from operations		\$11,250	\$11,250	\$11,250	\$11,250	\$11,250	
Total cash flow from project	\$ (150,000)	\$31,250	\$36,250	\$36,250	\$36,250	\$41,250	
PV 15% (CF)	(150,000)	= CF/1.15	= CF/(1.15) ²	= CF/(1.15) ³	= CF/(1.15) ⁴	= CF/(1.15) ⁵	
		27,174	27,410	23,835	20,726	20,509	(\$30,346)

Optimistic

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	NPV
<i>Investments:</i>							
Touch screen system	\$(150,000)						
Annual maintenance		\$(5,000)	\$(5,000)	\$(5,000)	\$(5,000)	\$(5,000)	
Change in NWC		\$(5,000)				\$ 5,000	
Wages saved		\$30,000	\$30,000	\$30,000	\$30,000	\$30,000	
Total cash flow from investments	\$ (150,000)	\$20,000	\$25,000	\$25,000	\$25,000	\$30,000	
<i>Income:</i>							
Revenue		\$20,000	\$20,000	\$20,000	\$20,000	\$20,000	
COGS		\$(5,000)	\$(5,000)	\$(5,000)	\$(5,000)	\$(5,000)	
Cash flow from operations		\$15,000	\$15,000	\$15,000	\$15,000	\$15,000	
Total cash flow from project	\$ (150,000)	\$35,000	\$40,000	\$40,000	\$40,000	\$45,000	
PV 15% (CF)	(150,000)	= CF/1.15	= CF/(1.15) ²	= CF/(1.15) ³	= CF/(1.15) ⁴	= CF/(1.15) ⁵	
		30,435	30,246	26,301	22,870	22,373	(\$17,776)

Since the NPV for all three scenarios is negative, they should not invest in this project.

- 8.19 a. Apply the 10-year annuity formula, discounted at 10 percent, to calculate the NPV of the video game.

$$\begin{aligned} \text{NPV} &= C_0 + C_1 A_r^T \\ &= -\$4,000,000 + \$750,000 A_{0.1}^{10} \\ &= \mathbf{\$608,425.33} \end{aligned}$$

The NPV of the video game is \$608,425.33.

- b. Calculate the revised NPV of the project. The firm expects to receive net cash flow of \$750,000 at the end of the first year of operations. Discount that value back one period to year 0.

$$\begin{aligned} \text{PV(Year 1 Cash Flow)} &= C_1 / (1+r)^T \\ &= \$750,000 / (1.1) \\ &= \mathbf{\$681,818.18} \end{aligned}$$

For the next nine years, the firm has a 50 percent chance of receiving annual cash flows of \$1,500,000 and a 50 percent chance of receiving annual cash flows of \$0. Should the firm receive cash flows of \$0, the firm should exercise the option of abandonment and receive the \$200,000 cash flow. The probability of exercising that option is 50 percent. Calculate the expected PV of the revised cash flows by applying the nine-year annuity formula. To calculate the expected PV as of year 0, discount that value back one period to year 0. The option is exercised in year 1 and must also be discounted back one period to year 0.

$$\begin{aligned} \text{PV(Revised)} &= (\text{Prob.} \times C_2 \times A_r^T + \text{Prob.} \times \text{Salvage}) / (1+r)^T \\ &= (0.5 \times \$1,500,000 \times A_{0.1}^9 + 0.5 \times \$200,000) / (1.1) \\ &= \mathbf{\$4,017,516.23} \end{aligned}$$

After including the initial investment, the revised NPV of the project is equal to the sum of the first year's cash flow, the PV of the expected cash flows for the next nine years, and the expected value of abandoning the project.

$$\begin{aligned} \text{Revised NPV} &= C_0 + C_1 / (1+r)^T + [(\text{Prob.} \times C_2 \times A_r^T) + (\text{Prob.} \times C_2)] / (1+r)^T \\ &= -\$4,000,000 + \$750,000 / (1.1) + \\ &\quad (0.5 \times \$1,500,000 \times A_{0.1}^9 + 0.5 \times \$200,000) / (1.1) \\ &= \mathbf{\$699,334.42} \end{aligned}$$

The revised NPV is \$699,334.42.

- c. The market value of the project, M , is the NPV of the project without an option to abandon plus the value of the option, Opt . The NPV of the project without the option to abandon was calculated in part (a). The difference between the NPV as calculated in part (a) and the revised NPV is equal to the option value of abandonment, Opt .

$$\begin{aligned} M &= \text{NPV} + Opt \\ \$699,334.42 &= \$608,425.33 + Opt \\ \mathbf{\$90,909.09} &= Opt \end{aligned}$$

The option value of abandonment is \$90,909.09.

- 8.20 a. Apply the 10-year annuity formula, discounted at 20 percent to calculate the NPV of the project. Total annual net cash flow is \$200,000,000.

$$\begin{aligned} \text{NPV} &= C_0 + C_1 A_r^T \\ &= -\$100,000,000 + \$200,000,000 A_{0.2}^{10} \\ &= \$738,494,417.11 \end{aligned}$$

The NPV of the project is \$738,494,417.11.

- b. Allied Products should abandon the project if the PV of the revised cash flows for the next nine years is less than the project's scrap value. Since the option to abandon the project occurs in year 1, discount the revised cash flows to year 1 as well. To determine the level of expected cash flows below which Allied should abandon the project, calculate the equivalent annual cash flows the project must earn to equal the scrap value, \$50 million. Set the scrap value equal to a nine-year annuity, discounted at 20 percent. Solve for C_1 .

$$\begin{aligned} \text{Scrap Value} &= C_1 A_r^T \\ \$50,000,000 &= C_1 A_{0.2}^9 \\ \$50,000,000 / A_{0.2}^9 &= C_1 \\ \mathbf{\$12,403,973.08} &= C_1 \end{aligned}$$

The firm should abandon the project after the first year if the revised expected annual cash flows are below \$12,403,973.08. Below that level, the firm is better off abandoning the project and receiving the \$50 million scrap value of the project.

- 8.21 a. NPV (1.932) $= -10 + 10*0.3*(1/0.25 - 1/0.25*(1/1.25)^5)$
 b. Option Value 2.000 $= 0.5*9/1.25$
 New NPV 0.068 $= -10 + 10*0.3/1.25 + 0.5*15*0.3*(1/0.25 - 1/0.25*(1/1.25)^4)/(1.25) + 0.5*9/1.25$

8.22 a)

	0	1	2	3	4	5
Initial investment	\$ (3,000,000)	\$ -	\$ -	\$ -	\$ -	\$ -
Cash flow from operations		\$ 2,500,000	\$ 2,500,000	\$ 2,500,000	\$ 2,500,000	\$ 2,500,000
Total cash flow from project	\$ (3,000,000)	\$ 2,500,000	\$ 2,500,000	\$ 2,500,000	\$ 2,500,000	\$ 2,500,000
PV 15% (CF)	(3,000,000)	= CF/1.15 2,173,913	= CF/(1.15) ² 1,890,359	= CF/(1.15) ³ 1,643,791	= CF/(1.15) ⁴ 1,429,383	= CF/(1.15) ⁵ 1,242,942
						\$5,380,388

b)

	0	1	2	3	4
Initial investment	\$ -	\$ -	\$ -	\$ -	\$ -
Cash flow from operations		\$ 500,000	\$ 500,000	\$ 500,000	\$ 500,000
Total cash flow from project	\$ -	\$ 500,000	\$ 500,000	\$ 500,000	\$ 500,000
PV 15% (CF)	= CF 0	= CF/1.15 434,783	= CF/(1.15) ² 378,072	= CF/(1.15) ³ 328,758	= CF/(1.15) ⁴ 285,877
					\$1,427,489

Since this amount is less than \$1.5 million, we would choose to abandon.

	0	1	2	3	4
Initial investment	\$ -	\$ -	\$ -	\$ -	\$ -
Cash flow from operations		\$ 4,000,000	\$ 4,000,000	\$ 4,000,000	\$ 4,000,000
Total cash flow from project	\$ -	\$ 4,000,000	\$ 4,000,000	\$ 4,000,000	\$ 4,000,000
PV 15% (CF)	= CF 0	= CF/1.15 3,478,261	= CF/(1.15) ² 3,024,575	= CF/(1.15) ³ 2,630,065	= CF/(1.15) ⁴ 2,287,013
					\$11,419,913

If we abandon, then we receive \$1,500,000. If it is a success, then we receive \$11,419,913.

These outcomes are equally likely so $(\$1,500,000 + 11,419,913)/2 =$

The present value is $6,459,957/1.15 =$

Therefore, the option to abandon is $5,617,354 - 5,380,388 =$

6,459,957
5,617,354
236,966