Chapter 13
Cash Flow Estimation and Risk Analysis

Learning Objectives

After reading this chapter, students should be able to:

- Identify "relevant" cash flows that should and should not be included in a capital budgeting analysis.
- Estimate a project's relevant cash flows and put them into a time line format that can be used to calculate a project's NPV, IRR, and other capital budgeting metrics.
- Explain how risk is measured, and use this measure to adjust the firm's WACC to account for differential project riskiness.
- Correctly calculate the NPV of mutually exclusive projects that have unequal lives.

Lecture Suggestions

This chapter covers some important but relatively technical topics. Note too that this chapter is more modular than most, i.e., the major sections are discrete, hence they can be omitted without loss of continuity. Therefore, if you are experiencing a time crunch, you could skip sections of the chapter.

What we cover, and the way we cover it, can be seen by scanning the slides and Integrated Case solution for Chapter 13, which appears at the end of this chapter's solutions. For other suggestions about the lecture, please see the "Lecture Suggestions" in Chapter 2, where we describe how we conduct our classes.

DAYS ON CHAPTER: 3 OF 56 DAYS (50-minute periods)

Answers to End-of-Chapter Questions

13-1 Only cash can be spent or reinvested, and since accounting profits do not represent cash, they are of less fundamental importance than cash flows for investment analysis. Recall that in the stock valuation chapter we focused on dividends, which represent cash flows, rather than on earnings per share.

13-2 Capital budgeting analysis should only include those cash flows that will be affected by the decision. Sunk costs are unrecoverable and cannot be changed, so they have no bearing on the capital budgeting decision. Opportunity costs represent the cash flows the firm gives up by investing in this project rather than its next best alternative, and externalities are the cash flows (both positive and negative) to other projects that result from the firm undertaking this project. These cash flows occur only because the firm took on the capital budgeting project; therefore, they must be included in the analysis.

12-3 When a firm takes on a new capital budgeting project, it typically must increase its investment in receivables and inventories, over and above the increase in payables and accruals, thus increasing its net operating working capital (NOWC). Since this increase must be financed, it is included as an outflow in Year 0 of the analysis. At the end of the project's life, inventories are depleted and receivables are collected. Thus, there is a decrease (or reduction) in NOWC, which represents an inflow in the final year of the project's life.

13-4 The costs associated with financing are reflected in the weighted average cost of capital. To include interest expense in the capital budgeting analysis would "double count" the cost of debt financing.

13-5 Daily cash flows would be theoretically best, but they would be costly to estimate and probably no more accurate than annual estimates because we simply cannot forecast accurately at a daily level. Therefore, in most cases we simply assume that all cash flows occur at the end of the year. However, for some projects it might be useful to assume that cash flows occur at mid-year, or even quarterly or monthly. There is no clear upward or downward bias on NPV since both revenues and costs are being recognized at the end of the year. Unless revenues and costs are distributed radically different throughout the year, there should be no bias.

13-6 In replacement projects, the benefits are generally cost savings, although the new machinery may also permit additional output. The data for replacement analysis are generally easier to obtain than for new products, but the analysis itself is somewhat more complicated because almost all of the cash flows are incremental, found by subtracting the new cost numbers from the old numbers. Similarly, differences in depreciation and any other factor that affects cash flows must also be determined.

13-7 Stand-alone risk is the project's risk if it is held as a lone asset. It disregards the fact that it is but one asset within the firm's portfolio of assets and that the firm is but one stock in a typical investor's portfolio of stocks. Stand-alone risk is measured by the variability of the project's expected returns. Corporate, or within-firm, risk is the project's risk to the corporation, giving consideration to the fact that the project represents only one asset in the firm's portfolio of assets, hence some of its risk will be eliminated by diversification within the firm. Corporate risk is measured by the project's impact on uncertainty about the firm's future earnings. Market, or beta, risk is the riskiness of the project as seen by well-diversified stockholders who recognize that the project is only one of the firm's assets and that the firm's stock is but one small part of their total portfolios. Market risk is measured by the project's effect on the firm's beta coefficient.

13-8 It is often difficult to quantify market risk. On the other hand, we can usually get a good idea of a project's stand-alone risk, and that risk is normally correlated with market risk: The higher the stand-alone risk, the higher the market risk is likely to be. Therefore, firms tend to focus on stand-alone risk, then deal with corporate and market risk by making subjective, judgmental modifications to the calculated stand-alone risk.

13-9 Simulation analysis involves working with continuous probability distributions, and the output of a simulation analysis is a distribution of net present values or rates of return. Scenario analysis involves picking several points on the various probability distributions and determining cash flows or rates of return for these points. Sensitivity analysis involves determining the extent to which cash flows change, given a change in one particular input variable. Simulation analysis is expensive. Therefore, it would more than likely be employed in the decision for the $500 million investment in a satellite communications system than in the decision for the $30,000 truck.

13-10 Scenario analyses, and especially simulation analyses, would probably be reserved for very important "make-or-break" decisions. They would not be used for every project decision because it is costly (in terms of money and time) to perform the necessary calculations and it is challenging to gather all the required information for a full analysis. Simulation analysis, in particular, requires data from many different departments about costs and projections, including the probability distributions corresponding to those estimates and the correlation coefficients between various variables.

13-11 The replacement chain approach is a method of comparing projects with unequal lives that assumes that each project can be repeated as many times as necessary to reach a common life span. As such, the NPVs over this life span are then compared, and the project with the higher positive common-life NPV is chosen.

13-12 The equivalent annual annuity method calculates the annual payments a project would provide if it were an annuity. When comparing projects of unequal lives, the one with the higher positive equivalent annual annuity should be chosen.

13-13 Generally, the failure to employ replacement chain analysis or the equivalent annual annuity approach in such situations will bias the NPV against the shorter project because it "gets no credit" for profits beyond its initial life, even though it could possibly be "renewed" and thus provide additional NPV.

Solutions to End-of-Chapter Problems

13-1 **a.**

Equipment purchase	($ 9,000,000)
NOWC investment	(3,000,000)
Initial investment outlay	($12,000,000)

b. No, last year's $50,000 expenditure is considered a sunk cost and does not represent an incremental cash flow. Hence, it should not be included in the analysis.

c. The potential sale of the building represents an opportunity cost of conducting the project in that building. Therefore, the possible proceeds after taxes and commissions must be charged against the project as a cost.

13-2 **a.** Project cash flows: t = 1

Sales revenues	$10,000,000
Operating costs	7,000,000
Depreciation	2,000,000
EBIT	$ 1,000,000
Taxes (40%)	400,000
EBIT(1 – T)	$ 600,000
Add back depreciation	2,000,000
Project cash flow = EBIT(1 – T) + DEP	$ 2,600,000

b. The cannibalization of existing sales needs to be considered in this analysis on an after-tax basis, because the cannibalized sales represent sales revenue the firm would realize without the new project but would lose if the new project is accepted. Thus, the after-tax effect would reduce the project's cash flow by $1,000,000(1 – T) = $1,000,000(0.6) = $600,000. Thus, the project's cash flow would now be $2,000,000 rather than $2,600,000.

c. If the tax rate fell to 30%, the project's cash flow would change to:

EBIT	$1,000,000
Taxes (30%)	300,000
EBIT(1 – T)	$ 700,000
Add back depreciation	2,000,000
Project cash flow = EBIT(1 – T) + DEP	$2,700,000

Thus, the project's cash flow would increase by $100,000.

13-3

Equipment's original cost	$20,000,000
Depreciation (80%)	16,000,000
Book value	$ 4,000,000

Gain on sale = $5,000,000 – $4,000,000 = $1,000,000.

Tax on gain = $1,000,000(0.4) = $400,000.

AT salvage value = $5,000,000 – $400,000 = $4,600,000.

13-4 Cash outflow = $40,000.

Increase in annual after-tax cash flows: CF = $9,000.

Place the cash flows on a time line:

0 (10%)	1	2	• • •	10
-40,000	9,000	9,000		9,000

With a financial calculator, input the appropriate cash flows into the cash flow register, input I/YR = 10, and then solve for NPV = $15,301.10. Thus, Chang should purchase the new machine.

13-5 First, solve for each project's NPV.

Project A: CF_0 = -20000, CF_1 = 6000, N_j = 6, I/YR = 10; solve for NPV = $6,131.56.
Project B: CF_0 = -12000, CF_1 = 6000, N_j = 3, I/YR = 10; solve for NPV = $2,921.11.

The appropriate EAAs are:

Project A: N = 6, I/YR = 10, PV = -6131.56, FV = 0; solve for PMT = EAA_A = $1,407.85.
Project B: N = 3, I/YR = 10, PV = -2921.11, FV = 0; solve for PMT = EAA_B = $1,174.62.

Choose Project A, whose EAA = $1,407.85.

13-6 **a.** The applicable depreciation values are as follows for the two scenarios:

Year	Scenario 1 (Straight-Line)	Scenario 2 (MACRS)
1	$200,000	$264,000
2	200,000	360,000
3	200,000	120,000
4	200,000	56,000

b. To find the difference in net present values under these two methods, we must determine the difference in incremental cash flows each method provides. The depreciation expenses cannot simply be subtracted from each other, as there are tax ramifications due to depreciation expense. The full depreciation expense is subtracted from revenues to arrive at operating income (EBIT), and then taxes due are calculated. Then, depreciation is added to after-tax operating income [EBIT(1 – T)] to obtain the project's operating cash flow. Therefore, if the tax rate is 40%, only 60% of the depreciation expense is actually subtracted out during the after-tax operating income calculation and the full depreciation expense is added back to calculate operating cash flow. So, there is a tax benefit associated with the depreciation expense that amounts to 40% of the depreciation expense. Therefore, the differences between depreciation expenses under each scenario should be calculated and multiplied by 0.4 to determine the benefit provided by the depreciation expense.

Year	ΔDepreciation Expense (2 – 1)	T × ΔDepreciation Expense
1	$ 64,000	$25,600
2	160,000	64,000
3	-80,000	-32,000
4	-144,000	-57,600

Now to find the difference in NPV to be generated under these scenarios, just enter the cash flows that represent the benefit from depreciation expense and solve for net present value based upon a WACC of 10%.

CF_0 = 0; CF_1 = 25600; CF_2 = 64000; CF_3 = -32000; CF_4 = -57600; and I/YR = 10. Solve for NPV = $12,781.64

So, all else equal, the use of the accelerated depreciation method will result in a higher NPV (by $12,781.64) than would the use of the straight-line depreciation method.

13-7 E(NPV) = 0.05(-$70) + 0.20(-$25) + 0.50($12) + 0.20($20) + 0.05($30)
= -$3.5 + -$5.0 + $6.0 + $4.0 + $1.5
= $3.0 million.

σ_{NPV} = $[0.05(-\$70 - \$3)^2 + 0.20(-\$25 - \$3)^2 + 0.50(\$12 - \$3)^2 + 0.20(\$20 - \$3)^2 + 0.05(\$30 - \$3)^2]^{½}$
= $23.622 million.

$$CV = \frac{\$23.622}{\$3.0} = 7.874.$$

13-8 **a.** CF_0 = -$178,000:

Initial investment outlay at t = 0:

Price	($140,000)
Modification	(30,000)
CAPEX	($170,000)
ΔNOWC	(8,000)
Initial investment outlay	($178,000)

b. *Project's operating cash flows:*

	Year 1	Year 2	Year 3
Savings	$50,000	$50,000	$50,000
Depreciation	56,100	76,500	25,500
EBIT	($ 6,100)	($26,500)	$24,500
Taxes (40%)	(2,440)	(10,600)	9,800
EBIT(1 – T)	($ 3,660)	($15,900)	$14,700
Add Depreciation	56,100	76,500	25,500
EBIT(1 –T) + DEP	$52,440	$60,600	$40,200
Terminal cash flows at t = 3:			
Salvage value			$60,000
Tax on salvage value			19,240
AT salvage value			$40,760
ΔNOWC = Recovery of NOWC			8,000
Project FCFs = EBIT(1 – T) + DEP – CAPEX – ΔNOWC	$52,440	$60,600	$88,960

Notes:

1. The depreciation expense in each year is the depreciable basis, $170,000, times the MACRS allowance percentages of 0.33, 0.45, and 0.15 for Years 1, 2, and 3, respectively. Depreciation expense in Years 1, 2, and 3 is $56,100, $76,500, and $25,500.

2. Remaining BV in Year 4 = $170,000(0.07) = $11,900.

   Tax on SV = ($60,000 – $11,900)(0.4) = $19,240.

c. The project has an NPV of ($19,549). Thus, it should not be accepted.

Year	Cash Flows	PV @ 12%
0	($178,000)	($178,000)
1	52,440	46,821
2	60,600	48,310
3	88,960	63,320
		NPV = ($ 19,549)

Alternatively, place the free cash flows on a time line:

	0 (12%)	1	2	3
Initial investment outlay	-178,000			
EBIT(1 – T) + DEP		52,440	60,600	40,200
Terminal cash flows				48,760
Project FCFs	-178,000	52,440	60,600	88,960

With a financial calculator, input the cash flows into the cash flow register, I/YR = 12, and then solve for NPV = -$19,548.65 ≈ -$19,549.

13-9 **a.** The $5,000 spent last year on exploring the feasibility of the project is a sunk cost and should not be included in the analysis.

b. The initial investment outlay at t = 0 is $126,000:

Price	($108,000)
Modification	(12,500)
CAPEX	($120,500)
ΔNOWC	(5,500)
Initial investment outlay	($126,000)

CF_0 = -$126,000.

c. The annual project cash flows follow:

Project's operating cash flows:

	Year 1	Year 2	Year 3
Savings	$44,000	$44,000	$44,000
Depreciation	39,765	54,225	18,075
EBIT	$ 4,235	($10,225)	$25,925
Taxes (35%)	1,482	(3,579)	9,074
EBIT(1 – T)	$ 2,753	($ 6,646)	$16,851
Add Depreciation	39,765	54,225	18,075
EBIT(1 –T) + DEP	$42,518	$47,579	$34,926
Terminal cash flows at time = 3:			
Salvage value			$65,000
Tax on salvage value			19,798
AT salvage value			$45,202
ΔNOWC = Recovery of NOWC	______	______	5,500
Project FCFs = EBIT(1 – T) + DEP – CAPEX – ΔNOWC	$42,518	$47,579	$85,628

Notes:

1. The depreciation expense in each year is the depreciable basis, $120,500, times the MACRS allowance percentages of 0.33, 0.45, and 0.15 for Years 1, 2, and 3, respectively. Depreciation expense in Years 1, 2, and 3 is $39,765, $54,225, and $18,075.

2. BV in Year 4 = $120,500(0.07) = $8,435.

   Tax on SV = ($65,000 – $8,435)(0.35) = $19,798.

d. The project has an NPV of $10,841; thus, it should be accepted.

Year	Cash Flows	PV @ 12%
0	($126,000)	($126,000)
1	42,518	37,963
2	47,579	37,930
3	85,628	60,948
		NPV = $ 10,841

Alternatively, place the free cash flows on a time line:

	0 (12%)	1	2	3
Initial investment outlay	-126,000			
EBIT(1 – T) + DEP		42,518	47,579	34,926
Terminal cash flows				50,702
Project FCFs	-126,000	42,518	47,579	85,628

With a financial calculator, input the appropriate cash flows into the cash flow register, input I/YR = 12, and then solve for NPV = $10,840.51 ≈ $10,841.

13-10 First determine the net cash flow at t = 0:

Purchase price	($8,000)
Sale of old machine	2,500
Tax on sale of old machine	(160)[a]
Change in net operating working capital	(1,500)[b]
Total investment	($7,160)

[a] The market value is $2,500 – $2,100 = $400 above the book value. Thus, there is a $400 recapture of depreciation, and Dauten would have to pay 0.40($400) = $160 in taxes.
[b] The change in net operating working capital is a $2,000 increase in current assets minus a $500 increase in accounts payable, which totals to $1,500.

Now, examine the annual cash inflows:

Sales increase	$1,000
Cost decrease	1,500
Increase in pre-tax revenues	$2,500

After-tax revenue increase:

$2,500(1 – T) = $2,500(0.60) = $1,500.

Depreciation:

Year	1	2	3	4	5	6
New[a]	$1,600	$2,560	$1,520	$960	$880	$480
Old	350	350	350	350	350	350
Change	$1,250	$2,210	$1,170	$610	$530	$130
Depreciation tax savings[b]	$ 500	$ 884	$ 468	$244	$212	$ 52

[a] Depreciable basis = $8,000. Depreciation expense in each year equals depreciable basis times the MACRS percentage allowances of 0.20, 0.32, 0.19, 0.12, 0.11, and 0.06 in Years 1-6, respectively.
[b] Depreciation tax savings = T(ΔDepreciation) = 0.4(ΔDepreciation).

Now recognize that at the end of Year 6 Dauten would recover its net operating working capital investment of $1,500, and it would also receive $800 from the sale of the replacement machine. However, since the machine would be fully depreciated, the firm must pay 0.40($800) = $320 in taxes on the sale. Also, by undertaking the replacement now, the firm forgoes the right to sell the old machine for $500 in Year 6; thus, this $500 in Year 6 must be considered an opportunity cost in that year. Taxes of $500(0.4) = $200 would be due because the old machine would be fully depreciated in Year 6, so the opportunity cost of the old machine would be $500 – $200 = $300.

Finally, place all the cash flows on a time line:

	0 (15%)	1	2	3	4	5	6
Net investment	(7,160)						
After-tax revenue increase		1,500	1,500	1,500	1,500	1,500	1,500
Depreciation tax savings		500	884	468	244	212	52
NOWC recovery							1,500
Salvage value of new machine							800
Tax on salvage value of new machine							(320)
Opportunity cost of old machine							(300)
Project cash flows	(7,160)	2,000	2,384	1,968	1,744	1,712	3,232

The net present value of this incremental cash flow stream, when discounted at 15%, is $921.36. Thus, the replacement should be made.

13-11 1. Net investment at t = 0:

Cost of new machine	($82,500)
Net investment outlay (CF_0)	($82,500)

2.

Year	After-tax Earnings	T(ΔDep)	Annual CF_t
1	$16,200	$ 6,600	$22,800
2	16,200	10,560	26,760
3	16,200	6,270	22,470
4	16,200	3,960	20,160
5	16,200	3,630	19,830
6	16,200	1,980	18,180
7	16,200	0	16,200
8	16,200	0	16,200

Notes:

a. The after-tax earnings are $27,000(1 – T) = $27,000(0.6) = $16,200.

b. Find ΔDep over Years 1-8:

The old machine was fully depreciated; therefore, ΔDep = Depreciation on the new machine.

Year	Dep Rate	Dep Basis	Depreciation
1	0.20	$82,500	$16,500
2	0.32	82,500	26,400
3	0.19	82,500	15,675
4	0.12	82,500	9,900
5	0.11	82,500	9,075
6	0.06	82,500	4,950
7-8	0.00	82,500	0

3. Now find the NPV of the replacement machine:

Place the cash flows on a time line:

0 (12%)	1	2	3	4	5	6	7	8
-82,500	22,800	26,760	22,470	20,160	19,830	18,180	16,200	16,200

With a financial calculator, input the appropriate cash flows into the cash flow register, input I/YR = 12, and then solve for NPV = $22,329.39. The NPV of the investment is positive; therefore, the new machine should be bought.

13-12 a. Expected annual cash flows:

Project A:

Probability	×	Cash Flow	=	Probable Cash Flow
0.2		$6,000		$1,200
0.6		6,750		4,050
0.2		7,500		1,500
		Expected annual cash flow	=	$6,750

Project B:

Probability	×	Cash Flow	=	Probable Cash Flow
0.2		$ 0		$ 0
0.6		6,750		4,050
0.2		18,000		3,600
		Expected annual cash flow	=	$7,650

Coefficient of variation:

$$CV = \frac{\text{Standard deviation}}{\text{Expected value}} = \frac{\sigma_{NPV}}{\text{Expected NPV}}$$

Project A:

$$\sigma_A = \sqrt{(-\$750)^2(0.2) + (\$0)^2(0.6) + (\$750)^2(0.2)} = \$474.34.$$

Project B:

$$\sigma_B = \sqrt{(-\$7,650)^2(0.2) + (-\$900)^2(0.6) + (\$10,350)^2(0.2)} = \$5,797.84.$$

CV_A = $474.34/$6,750 = 0.0703.

CV_B = $5,797.84/$7,650 = 0.7579.

b. Project B is the riskier project because it has the greater variability in its probable cash flows, whether measured by the standard deviation or the coefficient of variation. Hence, Project B is evaluated at the 12% cost of capital, while Project A requires only a 10% cost of capital.

Using a financial calculator, input the appropriate expected annual cash flows for Project A into the cash flow register, input I/YR = 10, and solve for NPV_A = $10,036.25.

Using a financial calculator, input the appropriate expected annual cash flows for Project B into the cash flow register, input I/YR = 12, and solve for NPV_B = $11,624.01.

Project B has the higher NPV; therefore, the firm should accept Project B.

c. The portfolio effects from Project B would tend to make it less risky than otherwise. This would tend to reinforce the decision to accept Project B. Again, if Project B were negatively correlated with the GDP (Project B is profitable when the economy is down), then it is less risky and Project B's acceptance is reinforced.

13-13 a. Project A:

0 (10%)	1	2
-10,000	6,000	8,000

Using a financial calculator, input the following data: CF_0 = -10000, CF_1 = 6000, CF_2 = 8000, I/YR = 10, and then solve for NPV_A = $2,066.12.

Project B:

0 (10%)	1	2	3	4
-10,000	4,000	4,000	4,000	4,000

Using a financial calculator, input the following data: CF_0 = -10000, $CF_{1\text{-}4}$ = 4000, I/YR = 10, and then solve for NPV_B = $2,679.46.

Since neither project can be repeated, Project B should be selected because it has a higher NPV than Project A.

b. To determine the answer to Part b, we use the replacement chain (common life) approach to calculate the extended NPV for Project A. Project B already extends out to 4 years, so its NPV is $2,679.46.

Project A:

0 (10%)	1	2	3	4
-10,000	6,000	8,000		
		-10,000	6,000	8,000
		-2,000		

Using a financial calculator, input the following data: CF_0 = -10000, CF_1 = 6000, CF_2 = -2000, CF_3 = 6000, CF_4 = 8000, I/YR = 10, and then solve for NPV_A = $3,773.65.

Since Project A's extended NPV = $3,773.65, it should be selected over Project B with an NPV = $2,679.46.

c. From Part a, NPV_A = $2,066.12 and NPV_B = $2,679.46. Solving for PMT determines the EAA:

Project A: N = 2, I/YR = 10, PV = -2066.12, FV = 0; solve for PMT = EAA_A = $1,190.48.

Project B: N = 4, I/YR = 10, PV = -2679.46, FV = 0; solve for PMT = EAA_B = $845.29.

Project A should be selected.

13-14

0 (14%)	1	2	3
-190,000	87,000	87,000	87,000

Using a financial calculator, input the following data: CF_0 = -190000; $CF_{1\text{-}3}$ = 87000; I/YR = 14; and solve for $NPV_{190\text{-}3}$ = $11,982 (for 3 years).

Extended $NPV_{190\text{-}3}$ = \$11,982 + \$11,982/(1.14)^3 = \$20,070.

$EAA_{190\text{-}3}$: Using a financial calculator, input the following data:
N = 3; I/YR = 14; PV = -11982; and FV = 0. Solve for PMT = $EAA_{190\text{-}3}$ = \$5,161.

0	1	2	3	4	5	6
14%						
-360,000	98,300	98,300	98,300	98,300	98,300	98,300

Using a financial calculator, input the following data: CF_0 = -360000; $CF_{1\text{-}6}$ = 98300; I/YR = 14; and solve for $NPV_{360\text{-}6}$ = \$22,256 (for 6 years).

$EAA_{360\text{-}6}$: Using a financial calculator, input the following data:
N = 6; I/YR = 14; PV = -22256; and FV = 0. Solve for PMT = $EAA_{360\text{-}6}$ = \$5,723.

Both new machines have positive NPVs; hence the old machine should be replaced. Further, since its NPV is greater with the replacement chain approach and its EAA is higher than Model 190-3, choose Model 360-6.

13-15 Since Plane A's renewal investment changes the EAA method cannot be used, so the replacement chain method must be used.

Plane A: Expected life = 5 years; cost = \$100 million; NCF = \$30 million; WACC = 12%; cost of renewing Plane A = \$105 million.

A:

0	1	2	3	4	5	6	7	8	9	10
12%										
-100	30	30	30	30	30					
					-105	30	30	30	30	30
					-75					

Enter these values into the cash flow register: CF_0 = -100; $CF_{1\text{-}4}$ = 30; CF_5 = -75; $CF_{6\text{-}10}$ = 30. Then enter I/YR = 12, and press the NPV key to get NPV_A = \$9.93 million.

Plane B: Expected life = 10 years; cost = \$132 million; NCF = \$25 million; WACC = 12%.

B:

0	1	2	3	4	5	6	7	8	9	10
12%										
-132	25	25	25	25	25	25	25	25	25	25

Enter these cash flows into the cash flow register, along with the interest rate, and press the NPV key to get NPV_B = \$9.256 ≈ \$9.26 million.

Project A is the better project and will increase the company's value by \$9.93 million.

13-16 A:

0	1	2	3	4	5	6	7	8
10%								
-10	4	4	4	4				
				-12	4.2	4.2	4.2	4.2
				-8				

Since Machine A's renewal investment and cash flows change the EAA method cannot be used, so the replacement chain method must be used. Machine A's simple NPV is calculated as follows: Enter CF_0 = -10 and $CF_{1\text{-}4}$ = 4. Then enter I/YR = 10, and press the NPV key to get NPV_A = $2.679 million. However, this does not consider the fact that the project can be repeated again. Enter these values into the cash flow register: CF_0 = -10; $CF_{1\text{-}3}$ = 4; CF_4 = -8; $CF_{5\text{-}8}$ = 4.2. Then enter I/YR = 10, and press the NPV key to get extended NPV_A = $3.58 million.

B: (10%)

0	1	2	3	4	5	6	7	8
-15	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5

Enter these cash flows into the cash flow register, along with the interest rate, and press the NPV key to get NPV_B = $3.672 ≈ $3.67 million.

Machine B is the better project and will increase the company's value by $3.67 million, rather than the $3.58 million created by Machine A.

13-17 First, solve for each project's NPV.

Project X: CF_0 = -100000, CF_1 = 30000, CF_2 = 50000, CF_3 = 70000, I/YR = 12; solve for NPV = $16,470.0255.

Project Y: CF_0 = -70000, CF_1 = 30000, N_j = 4, CF_2 = 10000, I/YR = 12; solve for NPV = $26,794.749.

The appropriate EAAs are:

Project X: N = 3, I/YR = 12, PV = -16470.0255, FV = 0; solve for PMT = EAA_X = $6,857.28 ≈ $6,857.

Project Y: N = 5, I/YR = 12, PV = -26794.749, FV = 0; solve for PMT = EAA_Y = $7,433.12 ≈ $7,433.

Choose Project Y.

13-18 If actual life is 5 years:

Using a time line approach:

	0 (10%)	1	2	3	4	5
Investment outlay	(36,000)					
Operating cash flows excl. deprec. (AT)		7,200	7,200	7,200	7,200	7,200
Depreciation savings		2,880	2,880	2,880	2,880	2,880
Project cash flows	(36,000)	10,080	10,080	10,080	10,080	10,080

$NPV_{10\%}$ = $2,211.13.

If actual life is 4 years:

Using a time line approach:

	0 (10%)	1	2	3	4
Investment outlay	(36,000)				
Operating cash flows excl. deprec. (AT)		7,200	7,200	7,200	7,200
Depreciation savings		2,880	2,880	2,880	2,880
Tax savings on loss					2,880
Project cash flows	(36,000)	10,080	10,080	10,080	12,960

$NPV_{10\%}$ = -$2,080.68.

If actual life is 8 years:

Using a time line approach:

	0 (10%)	1	...	5	6	7	8
Investment outlay	(36,000)						
Operating cash flows excl. deprec. (AT)		7,200		7,200	7,200	7,200	7,200
Depreciation savings		2,880		2,880			
Project cash flows	(36,000)	10,080		10,080	7,200	7,200	7,200

$NPV_{10\%}$ = $13,328.93.

If the life is as low as 4 years (an unlikely event), the investment will not be desirable. But, if the investment life is longer than 4 years, the investment will be a good one. Therefore, the decision will depend on the managers' confidence in the life of the tractor. If each of the indicated lives has the same probability of occurring E(NPV) = $4,486.46.

13-19 a.

	0	1	2	3	4	5
Capital expenditure	($250,000)					
NOWC	(25,000)					
Cost savings		$90,000	$ 90,000	$90,000	$90,000	$90,000
Depreciation[a]		82,500	112,500	37,500	17,500	0
EBIT		$ 7,500	($ 22,500)	$52,500	$72,500	$90,000
Taxes (40%)		3,000	(9,000)	21,000	29,000	36,000
EBIT(1 – T)		$ 4,500	($ 13,500)	$31,500	$43,500	$54,000
Add: Depreciation		82,500	112,500	37,500	17,500	0
EBIT(1 – T) + DEP		$87,000	$ 99,000	$69,000	$61,000	$54,000
Return of NOWC						$25,000
Salvage value						23,000
Tax on salvage value (40%)						(9,200)
Project cash flows	($275,000)	$87,000	$ 99,000	$69,000	$61,000	$92,800

NPV = $37,035.13
IRR = 15.30%
MIRR = 12.81%
Payback = 3.33 years

Notes:

[a] Depreciation Schedule, Basis = $250,000

Year	Beg. Bk. Value	MACRS Rate	MACRS Rate × Basis = Depreciation	Ending BV
1	$250,000	0.33	$ 82,500	$167,500
2	167,500	0.45	112,500	55,000
3	55,000	0.15	37,500	17,500
4	17,500	0.07	17,500	0
			$250,000	

b. If savings increase by 20%, then savings will be (1.2)($90,000) = $108,000.

If savings decrease by 20%, then savings will be (0.8)($90,000) = $72,000.

(1) Savings increase by 20%:

	0	1	2	3	4	5
Capital expenditure	($250,000)					
NOWC	(25,000)					
Cost savings		$108,000	$108,000	$108,000	$108,000	$108,000
Depreciation		82,500	112,500	37,500	17,500	0
EBIT		$ 25,500	($ 4,500)	$ 70,500	$ 90,500	$108,000
Taxes (40%)		10,200	(1,800)	28,200	36,200	43,200
EBIT(1 – T)		$ 15,300	($ 2,700)	$ 42,300	$ 54,300	$ 64,800
Add: Depreciation		82,500	112,500	37,500	17,500	0
EBIT(1 – T) + DEP		$ 97,800	$109,800	$ 79,800	$ 71,800	$ 64,800
Return of NOWC						$ 25,000
Salvage value						23,000
Tax on salvage value (40%)						(9,200)
Project cash flows	($275,000)	$ 97,800	$109,800	$ 79,800	$ 71,800	$103,600

NPV = $77,975.63

(2) Savings decrease by 20%:

	0	1	2	3	4	5
Capital expenditure	($250,000)					
NOWC	(25,000)					
Cost savings		$72,000	$ 72,000	$72,000	$72,000	$72,000
Depreciation		82,500	112,500	37,500	17,500	0
EBIT		($10,500)	($ 40,500)	$34,500	$54,500	$72,000
Taxes (40%)		(4,200)	(16,200)	13,800	21,800	28,800
EBIT(1 – T)		($ 6,300)	($ 24,300)	$20,700	$32,700	$43,200
Add: Depreciation		82,500	112,500	37,500	17,500	0
EBIT(1 – T) + DEP		$76,200	$ 88,200	$58,200	$50,200	$43,200
Return of NOWC						$25,000
Salvage value						23,000
Tax on salvage value (40%)						(9,200)
Project cash flows	($275,000)	$76,200	$ 88,200	$58,200	$50,200	$82,000

NPV = -$3,905.37

c. Worst-case scenario:

	0	1	2	3	4	5
Capital expenditure	($250,000)					
NOWC	(30,000)					
Cost savings		$72,000	$ 72,000	$72,000	$72,000	$72,000
Depreciation		82,500	112,500	37,500	17,500	0
EBIT		($10,500)	($ 40,500)	$34,500	$54,500	$72,000
Taxes (40%)		(4,200)	(16,200)	13,800	21,800	28,800
EBIT(1 – T)		($ 6,300)	($ 24,300)	$20,700	$32,700	$43,200
Add: Depreciation[a]		82,500	112,500	37,500	17,500	0
EBIT(1 – T) + DEP		$76,200	$ 88,200	$58,200	$50,200	$43,200
Return of NOWC						$30,000
Salvage value						18,000
Tax on salvage value (40%)						(7,200)
Project cash flows	($280,000)	$76,200	$ 88,200	$58,200	$50,200	$84,000

NPV = -$7,663.52

Base-case scenario:

This was worked out in Part a. NPV = $37,035.13.

Best-case scenario:

	0	1	2	3	4	5
Capital expenditure	($250,000)					
NOWC	(20,000)					
Cost savings		$108,000	$108,000	$108,000	$108,000	$108,000
Depreciation		82,500	112,500	37,500	17,500	0
EBIT		$ 25,500	($ 4,500)	$ 70,500	$ 90,500	$108,000
Taxes (40%)		10,200	(1,800)	28,200	36,200	43,200
EBIT(1 – T)		$ 15,300	($ 2,700)	$ 42,300	$ 54,300	$ 64,800
Add: Depreciation[a]		82,500	112,500	37,500	17,500	0
EBIT(1 – T) + DEP		$ 97,800	$109,800	$ 79,800	$ 71,800	$ 64,800
Return of NOWC						$ 20,000
Salvage value						28,000
Tax on salvage value (40%)						(11,200)
Project cash flows	($270,000)	$ 97,800	$109,800	$ 79,800	$ 71,800	$101,600

NPV = $81,733.79

	Prob.	NPV	Prob. × NPV
Worst-case	0.35	($ 7,663.52)	($ 2,682.23)
Base-case	0.35	37,035.13	12,962.30
Best-case	0.30	81,733.79	24,520.14
		E(NPV)	$34,800.21

σ_{NPV} = $[(0.35)(-\$7,663.52 - \$34,800.21)^2 + (0.35)(\$37,035.13 - \$34,800.21)^2 + (0.30)(\$81,733.79 - \$34,800.21)^2]^{½}$
= $[\$631,108,927.93 + \$1,748,203.59 + \$660,828,279.49]^{½}$
= $35,967.84.

CV = $35,967.84/$34,800.21 = 1.03.

13-20 a. Old depreciation = $9,000 per year.

Book value = $90,000 – 5($9,000) = $45,000.

Gain = $55,000 – $45,000 = $10,000.

Tax on book gain = $10,000(0.35) = $3,500.

Price	($150,000)
SV (old machine)	55,000
Tax effect	(3,500)
Initial outlay	($ 98,500)

b.

Year	Recovery Percentage	Depreciable Basis	Depreciation Allowance, New	Depreciation Allowance, Old	Change in Depreciation
1	33%	$150,000	$49,500	$9,000	$40,500
2	45	150,000	67,500	9,000	58,500
3	15	150,000	22,500	9,000	13,500
4	7	150,000	10,500	9,000	1,500
5				9,000	(9,000)

CF_t = (ΔOperating expenses)(1 – T) + (ΔDepreciation)(T).

CF_1 = ($50,000)(0.65) + ($40,500)(0.35) = $32,500 + $14,175 = $46,675.
CF_2 = ($50,000)(0.65) + ($58,500)(0.35) = $32,500 + $20,475 = $52,975.
CF_3 = ($50,000)(0.65) + ($13,500)(0.35) = $32,500 + $4,725 = $37,225.
CF_4 = ($50,000)(0.65) + ($1,500)(0.35) = $32,500 + $525 = $33,025.
CF_5 = ($50,000)(0.65) + (-$9,000)(0.35) = $32,500 – $3,150 = $29,350.

	0 (16%)	1	2	3	4	5
Purchase	(98,500)					
Operating CFs		46,675	52,975	37,225	33,025	29,350
Opportunity cost						(6,500)*
CFs	(98,500)	46,675	52,975	37,225	33,025	22,850

*After-tax opportunity cost of not being able to sell old machine at end of its useful life. It is calculated as $10,000(1 – 0.35) = $6,500.

c. From Part b input the data into your calculator as follows: CF_0 = -98500; CF_1 = 46675; CF_2 = 52975; CF_3 = 37225; CF_4 = 33025; CF_5 = 22850; I/YR = 16; and solve for NPV = $34,073.20. Therefore, the firm should replace the old machine.

13-21 a.

Cost of new machine	($1,175,000)
Salvage value, old	265,000
Savings due to loss on sale ($600,000 – $265,000) × 0.35	117,250
Cash outlay for new machine	($ 792,750)

b.

Year	Recovery Percentage	Depreciable Basis	Depreciation Allowance, New	Depreciation Allowance, Old	Change in Depreciation
1	20%	$1,175,000	$235,000	$120,000	$115,000
2	32	1,175,000	376,000	120,000	256,000
3	19	1,175,000	223,250	120,000	103,250
4	12	1,175,000	141,000	120,000	21,000
5	11	1,175,000	129,250	120,000	9,250

c. CF_t = (ΔOperating expenses)(1 – T) + (ΔDepreciation)(T).

CF_1 = ($255,000)(0.65) + ($115,000)(0.35) = $165,750 + $40,250 = $206,000.
CF_2 = ($255,000)(0.65) + ($256,000)(0.35) = $165,750 + $89,600 = $255,350.
CF_3 = ($255,000)(0.65) + ($103,250)(0.35) = $165,750 + $36,138 = $201,888.
CF_4 = ($255,000)(0.65) + ($21,000)(0.35) = $165,750 + $7,350 = $173,100.
CF_5 = ($255,000)(0.65) + ($9,250)(0.35) = $165,750 + $3,238 = $168,988.

A time line of the cash flows looks like this:

0	1	2	3	4	5
12%					
(792,750)	206,000	255,350	201,888	173,100	168,988
					118,925*
					287,913

*After-tax salvage of new machine at Year 5. After-tax salvage value is calculated as follows:

Book value = 0.06 × $1,175,000 = $70,500.

Tax on salvage value = (MV – BV) × T
= ($145,000 – $70,500) × 0.35
= $26,075.

After-tax salvage value = MV – Taxes
= $145,000 – $26,075
= $118,925.

d. From Part c input the data into your calculator as follows: CF_0 = -792750; CF_1 = 206000; CF_2 = 255350; CF_3 = 201888; CF_4 = 173100; CF_5 = 287913; I/YR = 12; and then solve for NPV = $11,819.67 ≈ $11,820. Since the NPV is positive, the project should be accepted. To buy the new machine would increase the value of the firm by $11,820.

e. 1. If the expected life of the old machine decreases, the new machine will look better as cash flows attributable to the new machine would increase. On the other hand, a serious complication arises: the two projects now have unequal lives, and an estimate must be made about the action to be taken when the old machine is scrapped. Will it be replaced, and at what cost and with what savings?

2. The higher capital cost should be used in the analysis, and this reduces the NPV of the project.

Comprehensive/Spreadsheet Problem

Note to Instructors:
The solution to this problem is <u>not</u> provided to students at the back of their text. Instructors can access the *Excel* file on the textbook's website or the Instructor's Resource CD.

13-22 a. **Part 5. Key Output: Evaluation of the Proposed Project**

Net Present Value (at 10%)	$4,014
IRR	11.11%
MIRR	10.75%
Payback; see calculation below)	2.49

Applies MIN function to Row 81 to find first year when payback is positive.

Data for Payback	Years	0	1	2	3
	Cumulative CF from Row 69	(195,000)	(124,200)	(45,000)	47,100
	IF Function to find payback		FALSE	FALSE	2.49

b. The $30,000 R&D costs are sunk costs. Therefore, these costs will have no effect on NPV and other profitability measures.

c. If the new project will reduce cash flows from the firm's other projects, then this is a negative externality and must be considered in the analysis. Consequently, these should be considered costs of the new project and would reduce the project's NPV. If the project can be housed in an empty building that the firm owns and could sell if it was not used for the project, then this is an opportunity cost which should also be considered as a "cost" of this project. The after-tax sales amount for this building will reduce the project's NPV.

d. The project's cash flows are likely to be positively correlated with returns on the firm's other projects and with the economy. The firm is involved with building materials, and caulking compound is a building material, so it is a similar product to the firm's other products. In addition, when the economy is booming, housing starts increase—which would mean an increase in sales of the caulking compound. Whether a project is positively or negatively correlated with the firm's other projects impacts the risk of the project and the relevant cost of capital at which it should be evaluated.

e. 1. **WACC:** 10.0%
Machine X:

	0	1	2	3	4
	(60,000)	25,000	25,000	25,000	25,000

NPV	19,247

WACC: 10.0%
Machine Y:

	0	1	2	3	4
	(60,000)	42,000	42,000		
			(60,000)	42,000	42,000
	(60,000)	42,000	(18,000)	42,000	42,000

2-yr NPV	12,893
Extended NPV	**23,548**

2. Machine X:

N	4
I/YR	10.00%
PV	(19,247)
FV	0
PMT = EAA	6,072

Machine Y:

N	2
I/YR	10.00%
PV	(12,893)
FV	0
PMT = EAA	7,429

Notice that both the replacement chain and EAA methods give the same project acceptance. Also, remember that the EAA uses the NPV of the original life of the project for Machine Y. Machine Y should be accepted because it has the higher NPV and the higher EAA.

f.

Key Output:		
	NPV =	$4,014
	IRR =	11.11%
	MIRR =	10.75%

Part 1. Key Input Data

Equipment cost plus installation	$175,000	Market value of equipment after 3 yrs	$15,000
Increase in current assets	$35,000	Tax rate	40%
Increase in current liabilities	$15,000	WACC	10%
Unit sales	115,000		
Sales price per unit	$3.25		
Variable cost per unit	60%		
Variable cost per unit (in dollars)	$1.95		
Fixed costs	$70,000		

Part 2. Depreciation and Amortization Schedule

		Years			Accum'd
Year	Initial Cost	1	2	3	Deprn
	175,000				
Equipment Deprn Rate		33.0%	45.0%	15.0%	
Equipment Deprn, Dollars		$57,750	$78,750	$26,250	$162,750
Ending Bk Val: Cost - Accum'd Deprn				$12,250	

Part 3. After-Tax Salvage Value at end of Year 3

	Equipment
Estimated Market Value	$15,000
Book Value	12,250
Expected Gain or Loss	2,750
Taxes paid or tax credit	1,100
After-tax salvage value	$13,900

Part 4. Project Cash Flow Analysis

	0	1	2	3
Investment Outlays at Time = 0				
Equipment	(175,000)			
Increase in NOWC	(20,000)			
Operating Cash Flows over the Project's Life				
Units sold		115,000	115,000	115,000
Sales price		$3.25	$3.25	$3.25
Sales revenues		$373,750	$373,750	$373,750
Variable costs		224,250	224,250	224,250
Fixed operating costs		70,000	70,000	70,000
Depreciation (equipment)		57,750	78,750	26,250
EBIT (Operating income)		$21,750	$750	$53,250
Taxes on operating income (40%)		8,700	300	21,300
EBIT (1 – T) = After-tax operating income		$13,050	$450	$31,950
Add back depreciation		57,750	78,750	26,250
EBIT (1 – T) + Depreciation		$70,800	$79,200	$58,200
Terminal Cash Flows at Time = 3				
Salvage value				$15,000
Tax on salvage value				1,100
After-tax salvage value				$13,900
Recovery of net operating working capital				20,000
Project FCFs = EBIT (1 – T) + DEP – CAPEX – ΔNOWC	($195,000)	$70,800	$79,200	$92,100

Part 5. Key Output: Evaluation of the Proposed Project

Net Present Value (at 10%)	$4,014
IRR	11.11%
MIRR	10.75%
Payback; see calculation below)	2.49

Applies MIN function to Row 81 to find first year when payback is positive.

Data for Payback	Years	0	1	2	3
	Cumulative CF from Row 69	(195,000)	(124,200)	(45,000)	47,100
	IF Function to find payback		FALSE	FALSE	2.49

g. Sensitivity of NPV to Changes in Inputs. Here we use an Excel "Data Table" to find NPV if each variable were better or worse than the base-case level, holding other things constant.

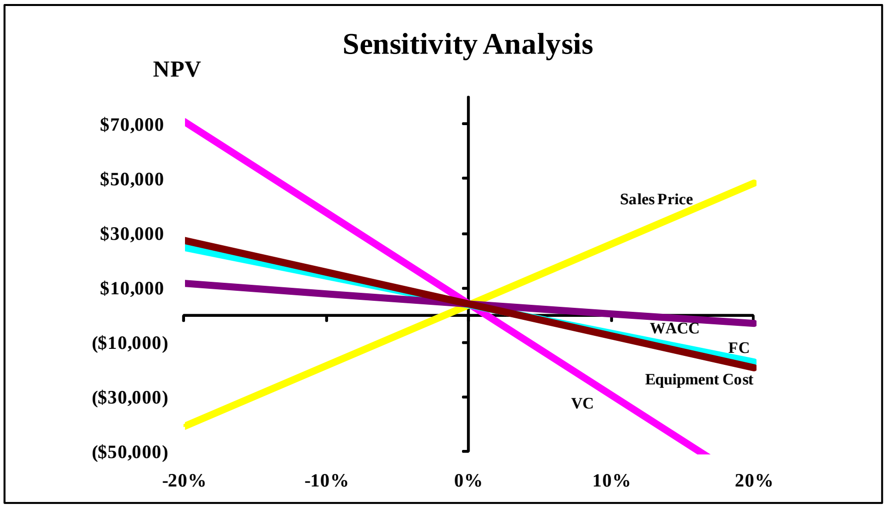
% Deviation from Base Case	UNIT SALES Units Sales	NPV $4,014		% Deviation from Base Case	WACC	NPV 4,014
-20%	92,000	-$40,600		-20%	8.0%	$11,569
-10%	103,500	-$18,293		-10%	9.0%	$7,733
0%	115,000	$4,014	Base Case	0%	10.0%	$4,014
10%	126,500	$26,321		10%	11.0%	$407
20%	138,000	$48,628		20%	12.0%	-$3,093

% Deviation from Base Case	VARIABLE COSTS Variable Costs	NPV $4,014		% Deviation from Base Case	SALES PRICE Sales Price	NPV $4,014
-20%	$1.56	$70,935		-20%	$2.60	-$40,600
-10%	$1.76	$37,475		-10%	$2.93	-$18,293
0%	$1.95	$4,014	Base Case	0%	$3.25	$4,014
10%	$2.15	-$29,446		10%	$3.58	$26,321
20%	$2.34	-$62,907		20%	$3.90	$48,628

% Deviation from Base Case	FIXED COSTS	
	Fixed Costs	NPV $4,014
-20%	$56,000	$24,904
-10%	$63,000	$14,459
0%	$70,000	$4,014
10%	$77,000	-$6,431
20%	$84,000	-$16,875

Base Case

% Deviation from Base Case	EQUIPMENT COST	
	Equipment Cost	NPV $4,014
-20%	$140,000	$27,294
-10%	$157,500	$15,654
0%	$175,000	$4,014
10%	$192,500	-$7,625
20%	$210,000	-$19,265

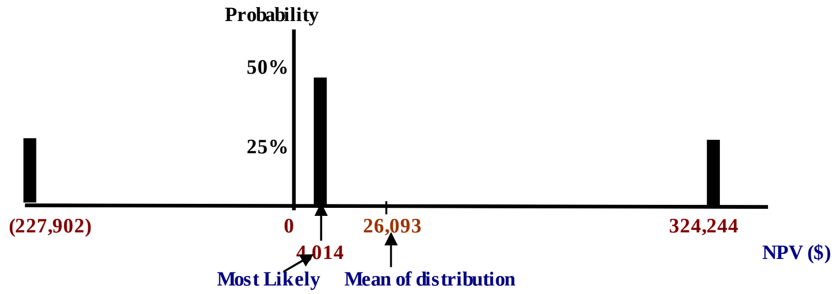


Deviation from Base Case	NPV at Different Deviations from Base					
	Sales Price	Variable Costs	Unit Sales	Fixed Costs	WACC	Equipment Cost
-20%	($40,600)	$70,935	($40,600)	$24,904	$11,569	$27,294
-10%	($18,293)	$37,475	($18,293)	$14,459	$7,733	$15,654
0%	$4,014	$4,014	$4,014	$4,014	$4,014	$4,014
10%	$26,321	($29,446)	$26,321	($6,431)	$407	($7,625)
20%	$48,628	($62,907)	$48,628	($16,875)	($3,093)	($19,265)
Range	89,228	133,842	89,228	41,779	14,662	46,559

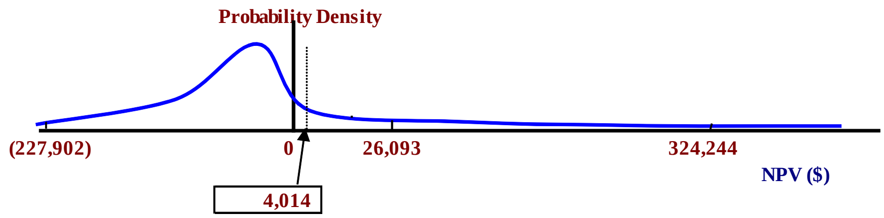
h. Note that "best-case" values for variable costs, fixed costs, WACC, and equipment cost are 20% less than base-case values, while the "worst-case" values for variable costs, fixed costs, WACC, and equipment cost are 20% higher than base-case values.

Scenario	Probability	Sales Price	Variable Costs	Unit Sales	Fixed Costs	WACC	Equipment Cost	NPV	Squared Deviation Times Probability
Best Case	25%	$3.90	$1.56	138,000	$56,000	8%	$140,000	$324,244	22223605763
Base Case	50%	$3.25	$1.95	115,000	$70,000	10%	$175,000	$4,014	243729670
Worst Case	25%	$2.60	$2.34	92,000	$84,000	12%	$210,000	($227,902)	16128328834
									38595664267
Expected NPV = sum, prob times NPV								$26,093	
Standard Deviation = Sq Root of column J sum								$196,458	
Coefficient of Variation = Std Dev / Expected NPV								7.53	

a. Probability Graph



b. Continuous Approximation



The scenario analysis suggests that the project could be highly profitable, but also that it is quite risky. There is a 25% probability that the project would result in a loss of $227,902. There is also a 25% probability that it could produce an NPV of $324,244. The standard deviation is high, at $196,458, and the coefficient of variation is high, 7.53.

i. A risk-adjusted discount rate is the cost of capital appropriate for a given project, given the riskiness of that project. The greater its risk, the higher the project's cost of capital. If Cory used a risk-adjusted discount rate, this project's cost of capital would be increased above the firm's 10% WACC to reflect its greater risk as determined from the project's CV of 7.53. If Cory increased the WACC used to analyze this project's NPV by 2 percentage points, then this project would not be accepted as its NPV at a 12% WACC would be -$3,093.

Integrated Case

13-23

Allied Food Products

Capital Budgeting and Cash Flow Estimation

Allied Food Products is considering expanding into the fruit juice business with a new fresh lemon juice product. Assume that you were recently hired as assistant to the director of capital budgeting and you must evaluate the new project.

The lemon juice would be produced in an unused building adjacent to Allied's Fort Myers plant; Allied owns the building, which is fully depreciated. The required equipment would cost $200,000, plus an additional $40,000 for shipping and installation. In addition, inventories would rise by $25,000, while accounts payable would increase by $5,000. All of these costs would be incurred at t = 0. By a special ruling, the machinery could be depreciated under the MACRS system as 3-year property. The applicable depreciation rates are 33%, 45%, 15%, and 7%.

The project is expected to operate for 4 years, at which time it will be terminated. The cash inflows are assumed to begin 1 year after the project is undertaken, or at t = 1, and to continue out to t = 4. At the end of the project's life (t = 4), the equipment is expected to have a salvage value of $25,000.

Unit sales are expected to total 100,000 units per year, and the expected sales price is $2.00 per unit. Cash operating costs for the project (total operating costs less depreciation) are expected to total 60% of dollar sales. Allied's tax rate is 40%, and its WACC is 10%. Tentatively, the lemon juice project is assumed to be of equal risk to Allied's other assets.

You have been asked to evaluate the project and to make a recommendation as to whether it should be accepted or rejected. To guide you in your analysis, your boss gave you the following set of tasks/questions:

Table IC 13.1. Allied's Lemon Juice Project (in Thousands)

End of Year:	0	1	2	3	4
I. Investment Outlays					
Equipment cost					
Installation	______				
CAPEX					
Increase in inventory					
Increase in accounts payable	______				
ΔNOWC					
II. Project Operating Cash Flows					
Unit sales (thousands)			100		
Price/unit		$ 2.00	$ 2.00	______	______
Total revenues		______	______	______	$200.0
Operating costs excluding depreciation			$120.0		
Depreciation		______	______	36.0	16.8
Total costs		$199.2	$228.0	______	______
EBIT (or operating income)				$ 44.0	
Taxes on operating income		0.3	______	______	25.3
EBIT(1 – T) = AT oper. income				$ 26.4	
Add back depreciation		79.2	______	36.0	______
EBIT(1 – T) + DEP		$ 79.7			$ 54.7
III. Project Termination Cash Flows					
Salvage value (taxed as ord. income)					
Tax on salvage value					______
After-tax salvage value					
ΔNOWC = Recovery of NOWC	______	______	______	______	______
Project free cash flows = EBIT(1 – T) + DEP – CAPEX – ΔNOWC	($260.0)	______	______	______	$ 89.7

IV. Results

NPV =

IRR =

MIRR =

Payback =

A. **Allied has a standard form that is used in the capital budgeting process. (See Table IC 13.1.) Part of the table has been completed, but you must replace the blanks with the missing numbers. Complete the table using the following steps:**

(1) Fill in the blanks under Year 0 for the initial investment outlays: CAPEX and ∆NOWC.

Answer: **[Show S13-1 through S13-5 here.] This answer is straightforward. Note that accounts payable is an offset to the inventory buildup, so the net operating working capital requirement is $20,000, which will be recovered at the end of the project's life. [See completed table in the answer to A(5).]**

A. **(2) Complete the table for unit sales, sales price, total revenues, and operating costs excluding depreciation.**

Answer: **This answer requires no explanation. Students may note, though, that inflation is not reflected at this point. It will be later. [The completed table is shown below in the answer to A(5).]**

A. **(3) Complete the depreciation data.**

Answer: **[Show S13-6 here.] The only item that requires explanation here is the use of the depreciation tables in Appendix 13A. Here are the rates for 3-year property; they are multiplied by the depreciable basis, $240,000, to calculate the annual depreciation allowances:**

(Dollars in thousands)

Year 1	0.33	×	$240	=	$ 79.2
Year 2	0.45	×	$240	=	108.0
Year 3	0.15	×	$240	=	36.0
Year 4	0.07	×	$240	=	16.8
	1.00				$240.0

A. (4) Complete the table down to after-tax operating income and then down to the project's operating cash flows, EBIT(1 –T) + DEP.

Answer: [Show S13-7 here.] This is straightforward. The only even slightly complicated item is adding back depreciation to calculate after-tax operating income. [The completed table is shown below in the answer to A(5).]

A. (5) Fill in the blanks under Year 4 for the terminal cash flows, and complete the project free cash flow line. Discuss the recovery of net operating working capital. What would have happened if the machinery were sold for less than its book value?

Answer: [Show S13-8 and S13-9 here.] These are all straightforward. Note that the net operating working capital requirement is recovered at the end of Year 4. Also, the salvage value is fully taxable, because the asset has been depreciated to a zero book value. If book value were something other than zero, the tax effect could be positive (if the asset were sold for less than book value) or negative.

Table IC 13.1. Allied's Lemon Juice Project (in Thousands)

Inputs:	Price:	$2.00	WACC:	10%	Infl:	0.0%
	VC rate:	60.0%	T-rate:	40%		

End of Year:	0	1	2	3	4
I. Investment Outlays					
Equipment cost	($ 200)				
Installation	(40)				
CAPEX	($ 240)				
Increase in inventory	(25)				
Increase in accounts payable	5				
ΔNOWC	($ 20)				
II. Project Operating Cash Flows					
Unit sales (thousands)		100	100	100	100
Price/unit		$ 2.00	$ 2.00	$ 2.00	$ 2.00
Total revenues		$200.0	$200.0	$200.0	$200.0
Operating costs excluding depreciation		$120.0	$120.0	$120.0	$120.0
Depreciation		79.2	108.0	36.0	16.8
Total costs		$199.2	$228.0	$156.0	$136.8
EBIT (or operating income)		$ 0.8	($ 28.0)	$ 44.0	$ 63.2
Taxes on operating income		0.3	(11.2)	17.6	25.3
EBIT(1 –T) = AT oper. income		$ 0.5	($ 16.8)	$ 26.4	$ 37.9
Add back depreciation		79.2	108.0	36.0	16.8
EBIT(1 – T) + DEP		$ 79.7	$ 91.2	$ 62.4	$ 54.7
III. Project Termination Cash Flows					
Salvage value (taxed as ord. income)					25.0
Tax on salvage value					10.0
After-tax salvage value					$ 15.0
ΔNOWC = Recovery of NOWC					20.0
Project free cash flows = EBIT(1 – T) + DEP – CAPEX – ΔNOWC	($260.0)	$ 79.7	$ 91.2	$ 62.4	$ 89.7

IV. Results

NPV = -$4.0
IRR = 9.3%
MIRR = 9.6%
Payback = 3.3 years

B. (1) Allied uses debt in its capital structure, so some of the money used to finance the project will be debt. Given this fact, should the projected cash flows be revised to show projected interest charges? Explain.

Answer: **[Show S13-10 here.] The projected cash flows in the table <u>should not</u> be revised to show interest charges. The effects of debt financing are reflected in the cost of capital (WACC), which is used to discount the cash flows. Including interest charges would constitute a "double counting" of the cost of debt financing.**

B. (2) Suppose you learned that Allied had spent $50,000 to renovate the building last year, expensing these costs. Should this cost be reflected in the analysis? Explain.

Answer: **[Show S13-11 here.] This expenditure is a sunk cost, hence it would not affect the decision and should not be included in the analysis.**

B. (3) Suppose you learned that Allied could lease its building to another party and earn $25,000 per year. Should that fact be reflected in the analysis? If so, how?

Answer: **[Show S13-12 here.] The rental payment represents an <u>opportunity cost</u>, and as such its after-tax amount, $25,000(1 – T) = $25,000(0.6) = $15,000, should be subtracted from the cash flows the company would otherwise receive.**

B. (4) Assume that the lemon juice project would take profitable sales away from Allied's fresh orange juice business. Should that fact be reflected in your analysis? If so, how?

Answer: **[Show S13-13 here.] The decreased sales from Allied's fresh orange juice business should be accounted for in the analysis. This is an externality to Allied—the lemon juice project will affect the cash flows to its orange juice business. Since the lemon juice project will take business away from its orange juice business, the revenues as shown in this analysis are overstated, and thus they need to be reduced by the amount of decreased revenues for the orange juice business. Externalities are often difficult to quantify, but they need to be considered.**

C. Disregard all the assumptions made in Part B and assume there is no alternative use for the building over the next 4 years. Now calculate the project's NPV, IRR, MIRR, and payback. Do these indicators suggest that the project should be accepted? Explain.

Answer: **[Show S13-14 here.] We refer to the completed time line and explain how each of the indicators is calculated. We base our explanation on financial calculators, but it would be equally easy to explain using a regular calculator and either equations or spreadsheets.**

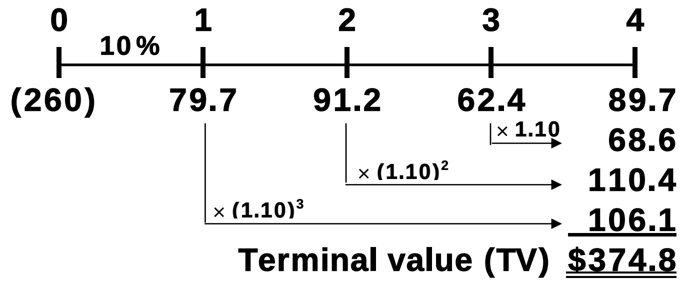
0	1	2	3	4
10%				
(260)	79.7	91.2	62.4	89.7

NPV = -$4.0. NPV is negative; do not accept.

$$\text{IRR} = -\$260 + \frac{\$79.7}{(1+\text{IRR})^1} + \frac{\$91.2}{(1+\text{IRR})^2} + \frac{\$62.4}{(1+\text{IRR})^3} + \frac{\$89.7}{(1+\text{IRR})^4} = 0.$$

IRR = 9.3%. IRR is less than the cost of capital; do not accept.

MIRR:



PV of TV $260

NPV $ 0

MIRR = 9.6% and is less than the cost of capital; do not accept.

Payback:

Year	Cash Flow	Cumulative Cash Flow
0	($260.0)	($260.0)
1	79.7	(180.3)
2	91.2	(89.1)
3	62.4	(26.7)
4	89.7	63.0

Payback = 3 years + $26.7/$89.7 = 3.3 years.

Based on the analysis to this point, the project should not be undertaken. However, this conclusion may not be correct, as we will see shortly.

D. If this project had been a replacement rather than an expansion project, how would the analysis have changed? Think about the changes that would have to occur in the cash flow table.

Answer: [Show S13-15 here.] In a replacement analysis, we must find differences in cash flows, i.e., the cash flows that would exist if we take on the project versus if we do not. Thus, in the table there would need to be, for each year, a column for no change, a column for the new project, and for the difference. The difference column is the one that would be used to obtain the NPV, IRR, etc.

E. (1) What three levels, or types, of project risk are normally considered?

Answer: **[Show S13-16 through S13-19 here.] Here are the three types of project risk:**

1. **Stand-alone risk is the project's total risk if it were operated independently. Stand-alone risk ignores both the firm's diversification among projects and investors' diversification among firms. Stand-alone risk is measured either by the project's standard deviation (σ_{NPV}) or its coefficient of variation of NPV (CV_{NPV}).**

2. **Within-firm (corporate) risk is the total riskiness of the project giving consideration to the firm's other projects, that is, to diversification within the firm. It is the contribution of the project to the firm's total risk, and it is a function of (a) the project's standard deviation of NPV and (2) the correlation of the projects' returns with those of the rest of the firm. Within-firm risk is often called corporate risk, and it is measured by the beta of the project's ROA versus the firm's ROA.**

3. **Market risk is the riskiness of the project to a well-diversified investor. Theoretically, it is measured by the project's beta, and it considers both corporate risk and stockholder diversification.**

E. (2) Which type is most relevant?

Answer: **[Show S13-20 here.] Because management's primary goal is shareholder wealth maximization, the most relevant risk for capital projects is market risk. However, creditors, customers, suppliers, and employees are all affected by a firm's total risk. Since these parties influence the firm's profitability, a project's within-firm risk should not be completely ignored.**

E. (3) Which type is easiest to measure?

Answer: **[Show S13-21 here.] By far the easiest type of risk to measure is a project's stand-alone risk. Thus, firms often focus primarily on this type of risk when making capital budgeting decisions. This focus is not theoretically correct, but it does not necessarily lead to poor decisions, because most projects that a firm undertakes are in its core business.**

E. (4) Are the three types of risk generally highly correlated?

Answer: **[Show S13-22 here.] Because most projects that a firm undertakes are in its core business, a project's stand-alone risk is likely to be highly correlated with its corporate risk, which in turn is likely to be highly correlated with its market risk.**

F. (1) What is sensitivity analysis?

Answer: **[Show S13-23 here.] <u>Sensitivity analysis</u> measures the effect of changes in a particular variable, say revenues, on a project's NPV. To perform a sensitivity analysis, all variables are fixed at their expected values except one. This one variable is then changed, often by specified percentages, and the resulting effect on NPV is noted. (One could allow more than one variable to change, but this then merges sensitivity analysis into scenario analysis.)**

F. (2) How would you perform a sensitivity analysis on the unit sales, salvage value, and WACC for the project? Assume that each of these variables deviates from its base-case, or expected, value by plus or minus 10%, 20%, and 30%. Explain how you would calculate the NPV, IRR, MIRR, and payback for each case; but don't do the analysis unless your instructor asks you to.

Answer: The base case value for unit sales was 100; therefore, if you were to assume that this value deviated by plus and minus 10%, 20%, and 30%, the unit sales values to be used in the sensitivity analysis would be 70, 80, 90, 110, 120, and 130 units. You would then go back to the table at the beginning of the problem, insert the appropriate sales unit number, say 70 units, and rework the table for the change in sales units arriving at different project cash flow values for the project. Once you had the project cash flow values, you would calculate the NPV, IRR, MIRR, and payback as you did previously. (Note that sensitivity analysis involves making a change to only one variable to see how it impacts other variables.) Then, you would go back and repeat the same steps for 80 units—this would be done for each of the unit sales values. Then, you would repeat the same procedure for the sensitivity analysis on salvage value and on cost of capital. (Note that for the cost of capital analysis, the project cash flows would remain the same, but the cost of capital used in the NPV and MIRR calculations would be different.)

Excel is ideally suited for sensitivity analysis. In fact we created a spreadsheet to obtain this project's cash flows and its NPV, IRR, MIRR, and payback. Once a model has been created, it is very easy to change the values of variables and obtain the new results. The results of the sensitivity analysis on the project's NPV (for the 5% inflation case, using Table IC 13.2) assuming the plus and minus 10%, 20%, and 30% deviations are shown below.

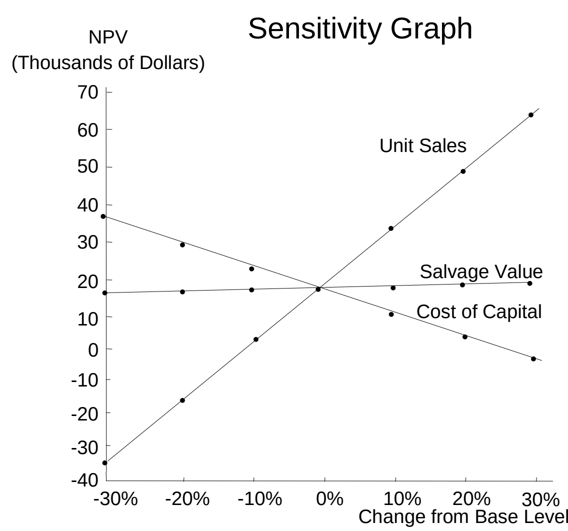
We generated these data with a spreadsheet model.

1. The sensitivity lines intersect at 0% change and the base case NPV, at approximately $15,000. Since all other variables are set at their base case, or expected, values, the zero change situation is the base case.

2. The plots for unit sales and salvage value are upward sloping, indicating that higher variable values lead to higher NPVs. Conversely, the plot for WACC is downward sloping, because a higher WACC leads to a lower NPV.

3. The plot of unit sales is much steeper than that for salvage value. This indicates that NPV is more sensitive to changes in unit sales than to changes in salvage value.

4. Steeper sensitivity lines indicate greater risk. Thus, in comparing two projects, the one with the steeper lines is considered to be riskier.



The sensitivity data are given here in tabular form (in thousands of dollars):

Change from Base Level	Resulting NPV after the Indicated Change in: Unit Sales	Salvage Value	WACC
-30%	($36.4)	$11.9	$34.1
-20	(19.3)	12.9	27.5
-10	(2.1)	13.9	21.1
0	15.0	15.0	15.0
+10	32.1	16.0	9.0
+20	49.2	17.0	3.3
+30	66.3	18.0	(2.2)

F. (3) What is the primary weakness of sensitivity analysis? What are its primary advantages?

Answer: [Show S13-24 here.] The two primary disadvantages of sensitivity analysis are (1) that it does not reflect the effects of diversification and (2) that it does not incorporate any information about the possible magnitudes of the forecast errors. Thus, a sensitivity analysis might indicate that a project's NPV is highly sensitive to the sales forecast, hence that the project is quite risky, but if the project's sales, hence its revenues, are fixed by a long-term contract, then sales variations may actually contribute little to the project's risk.

Therefore, in many situations, sensitivity analysis is not a particularly good indicator of risk. However, sensitivity analysis does identify those variables that potentially have the greatest impact on profitability, and this helps management focus its attention on those variables that are probably most important.

G.	Unrelated to the lemon juice project, Allied is upgrading its plant and must choose between two machines that are mutually exclusive. The plant is highly successful, so whichever machine is chosen will be repurchased after its useful life is over. Both machines cost $50,000; however, Machine A provides after-tax savings of $17,500 per year for 4 years, while Machine B provides after-tax savings of $34,000 in Year 1 and $27,500 in Year 2.

(1) Using the replacement chain method, what is the NPV of the better machine?

Answer: [Show S13-25 through S13-27 here.]

Machine A:

	0	1	2	3	4
10%					
	-50,000	17,500	17,500	17,500	17,500

Using a financial calculator, enter CF_0 = -50000, $CF_{1\text{-}4}$ = 17500, I/YR = 10, and solve for NPV.

NPV = $5,472.65

Machine B:

	0	1	2	3	4
10%					
	-50,000	34,000	27,500		
			-50,000	34,000	27,500
	-50,000	34,000	-22,500	34,000	27,500

Consider only 2-year life:

Using a financial calculator, enter CF_0 = -50000, CF_1 = 34000, CF_2 = 27500, I/YR = 10, and solve for NPV.

2-year NPV = $3,636.36

Machine will be replaced, so calculate extended NPV over 4 years:

Using a financial calculator, enter CF_0 = -50,000, CF_1 = 34000, CF_2 = -22500, CF_3 = 34000, CF_4 = 27500, I/YR = 10, and solve for NPV.

Extended NPV = $6,641.62

Because the machines will be repurchased the analysis should be made over a 4-year period. The extended NPV of Machine B is higher than Machine A, so Machine B should be selected.

G.	**(2)**	**Using the EAA method, what is the EAA of the better machine?**

Answer: **[Show S13-28 here.]**

Machine A:
N = 4
I/YR = 10
PV = -5472.65
FV = 0

EAA_A = PMT = $1,726.46

Machine B:
N = 2
I/YR = 10
PV = -3636.36
FV = 0

EAA_B = PMT = $2,095.24

Machine B has the higher EAA, so it should be selected.

Students should notice that both approaches reach the same conclusion: Machine B is the better project so it should be selected by the firm.

Work out quantitative answers to the remaining questions only if your instructor asks you to. Also note that it will take a <u>long time</u> to do the calculations unless you are using an *Excel* model.

H.	**Assume that inflation is expected to average 5% over the next 4 years and that this expectation is reflected in the WACC. Moreover, inflation is expected to increase revenues and variable costs by this same 5%. Does it appear that inflation has been dealt with properly in the initial analysis to this point? If not, what should be done and how would the required adjustment affect the decision?**

Answer: **[Show S13-29 through S13-31 here.] It is apparent from the data in the previous table that inflation has not been reflected in the calculations. In particular, the sales price is held constant rather than rising with inflation. Therefore, revenues and costs (except depreciation) should both be increased by 5% per year. Since revenues are larger than operating costs, inflation will cause cash flows to increase. This will lead to a higher NPV, IRR, and MIRR, and to a shorter payback. Table IC 13.2 reflects the changes, and it shows the new cash flows and results. When inflation is properly accounted for the project is profitable.**

Table IC 13.2. Allied's Lemon Juice Project Considering 5% Inflation (in Thousands)

Inputs:	**Price:**	**$2.00**	**WACC:**	**10%**		**Infl:**	**5.0%**
	VC rate:	**60.0%**	**T-rate:**	**40%**			

End of Year:	**0**	**1**	**2**	**3**	**4**
Investment Outlays:					
CAPEX	($240)				
∆NOWC	(20)				
Project Operating Cash Flows:					
Unit sales (thousands)		100	100	100	100
Sales price (dollars)		$ 2.10	$2.205	$2.315	$2.431
Total revenues		$210.0	$220.5	$231.5	$243.1
Cash operating costs (60%)		$126.0	$132.3	$138.9	$145.9
Depreciation		79.2	108.0	36.0	16.8
EBIT (or operating income)		$ 4.8	($ 19.8)	$ 56.6	$ 80.4
Taxes on operating income (40%)		1.9	(7.9)	22.6	32.1
EBIT(1 – T) = After-tax operating income		$ 2.9	($ 11.9)	$ 34.0	$ 48.3
Plus depreciation		79.2	108.0	36.0	16.8
EBIT(1 –T) + DEP		$ 82.1	$ 96.1	$ 70.0	$ 65.1
Terminal Cash Flows:					
Salvage value					25.0
Tax on salvage value (40%)					10.0
After-tax salvage value					15.0
∆NOWC					20.0
Project free cash flows	($260.0)	$ 82.1	$ 96.1	$ 70.0	$100.1
Cumulative cash flows for payback:	(260.0)	(177.9)	(81.8)	(11.8)	88.3
Compounded inflows for MIRR:		109.2	116.3	77.0	100.1
Sum of compounded inflows:					402.6

Results:

NPV = $15.0
IRR = 12.6%
MIRR = 11.6%
Payback = 3.1 years

I. The expected cash flows, considering inflation (in thousands of dollars), are given in Table IC 13.2. Allied's WACC is 10%. Assume that you are confident about the estimates of all the variables that affect the cash flows except unit sales. If product acceptance is poor, sales would be only 75,000 units a year, while a strong consumer response would produce sales of 125,000 units. In either case, cash costs would still amount to 60% of revenues. You believe that there is a 25% chance of poor acceptance, a 25% chance of excellent acceptance, and a 50% chance of average acceptance (the base case). Provide numbers only if you are using a computer model.

(1) What is the worst-case NPV? The best-case NPV?

Answer: [Show S13-32 and S13-33 here.] We used a spreadsheet model to develop the scenarios (in thousands of dollars), which are summarized below:

Case	Probability	NPV (000s)
Worst	0.25	($27.8)
Base	0.50	15.0
Best	0.25	57.8

I. (2) Use the worst-case, most likely case (or base-case), and best-case NPVs with their probabilities of occurrence, to find the project's expected NPV, standard deviation, and coefficient of variation.

Answer: [Show S13-34 here.] The expected NPV is $14,968 (rounded to the nearest thousand below).

E(NPV) = 0.25(-$27.8) + 0.50($15.0) + 0.25($57.8) = $15.

The standard deviation of NPV is $30.3:

$$\sigma_{NPV} = [0.25(-\$27.8 - \$15)^2 + 0.50(\$15 - \$15)^2 + 0.25(\$57.8 - \$15)^2]^{½} = [916]^{½} = \$30.3.$$

The project's coefficient of variation is 2.0:

$$CV_{NPV} = \frac{\sigma_{NPV}}{E(NPV)} = \frac{\$30.3}{\$15} = 2.0.$$

J.	**Assume that Allied's average project has a coefficient of variation (CV) in the range of 1.25 to 1.75. Would the lemon juice project be classified as high risk, average risk, or low risk? What type of risk is being measured here?**

Answer: **[Show S13-35 here.] The project has a CV of 2.0, which is much higher than the average range of 1.25 to 1.75, so it falls into the high-risk category. The CV measures a project's stand-alone risk—it is merely a measure of the variability of returns (as measured by σ_{NPV}) about the expected return.**

K.	**Based on common sense, how highly correlated do you think the project would be with the firm's other assets? (Give a correlation coefficient or range of coefficients, based on your judgment.)**

Answer: **[Show S13-36 here.] It is reasonable to assume that if the economy is strong and people are buying a lot of lemon juice, then sales would be strong in all of the company's lines, so there would be positive correlation between this project and the rest of the business. However, each line could be more or less successful, so the correlation would be less than +1.0. A reasonable guess might be +0.7, or within a range of +0.5 to +0.9.**

L.	**How would the correlation coefficient and the previously calculated σ combine to affect the project's contribution to corporate, or within-firm, risk? Explain.**

Answer: [Show S13-37 here.] If the project's cash flows are likely to be highly correlated with the firm's aggregate cash flows, which is generally a reasonable assumption, then the project would have high corporate risk. However, if the project's cash flows were expected to be totally uncorrelated with the firm's aggregate cash flows, or positively correlated but less than perfectly positively correlated, then accepting the project would reduce the firm's total risk, and in that case, the riskiness of the project would be less than suggested by its stand-alone risk. If the project's cash flows were expected to be negatively correlated with the firm's aggregate cash flows, then the project would reduce the total risk of the firm even more.

M. Based on your judgment, what do you think the project's correlation coefficient would be with respect to the general economy and thus with returns on "the market"? How would correlation with the economy affect the project's market risk?

Answer: In all likelihood, this project would have a positive correlation with returns on other assets in the economy, and specifically with the stock market. Allied Food Products produces food items, and such firms tend to have less risk than the economy as a whole—people must eat regardless of the national economic situation. However, people would tend to spend more on non-essential types of food when the economy is good and to cut back when the economy is weak. A reasonable guess might be +0.7, or within a range of +0.5 to +0.9. If an asset (project, in this case) has a high correlation with the market, it has a high beta, and hence high market risk.

N. **Allied typically adds or subtracts 3% to its WACC to adjust for risk. After adjusting for risk, should the lemon juice project be accepted? Should any subjective risk factors be considered before the final decision is made? Explain.**

Answer: [Show S13-38 and S13-39 here.] Since the project is judged to have above-average risk, its differential risk-adjusted, or project, cost of capital would be 13%. At this discount rate, its NPV would be -$2,226, so it would not be acceptable. If it were a low-risk project, its cost of capital would be 7%, its NPV would be $34,117, and it would be a profitable project on a risk-adjusted basis. However, a numerical analysis such as this one may not capture all of the risk factors inherent in the project. If the project has a potential for bringing on harmful lawsuits, then it might be riskier than first assessed. Also, if the project's assets can be redeployed within the firm or can be easily sold, then the project may be less risky than the analysis indicates.