Chapter 11
Cash Flow Estimation and Risk Analysis
ANSWERS TO END-OF-CHAPTER QUESTIONS

11-1 a. Project cash flow, which is the relevant cash flow for project analysis, represents the actual flow of cash, which includes investments in capital and working capital, but does not include interest expenses or noncash charges like depreciation (except to the extent that depreciation affects taxes). In other words, project cash flow is the free cash flow generated by the project. Accounting income, on the other hand, reports accounting data as defined by Generally Accepted Accounting Principles (GAAP).

b. Incremental cash flows are those cash flows that arise solely from the asset that is being evaluated. For example, assume an existing machine generates revenues of $1,000 per year and expenses of $600 per year. A machine being considered as a replacement would generate revenues of $1,000 per year and expenses of $400 per year. On an incremental basis, the new machine would not increase revenues at all, but would decrease expenses by $200 per year. Thus, the annual incremental cash flow is a before-tax savings of $200. A sunk cost is one that has already occurred and is not affected by the capital project decision. Sunk costs are not relevant to capital budgeting decisions. Within the context of this chapter, an opportunity cost is a cash flow that a firm must forgo to accept a project. For example, if the project requires the use of a building that could otherwise be sold, the market value of the building is an opportunity cost of the project. An externality is something that is external to the project but occurs because of the project. For example, cannibalization occurs when a project's product reduces the company's sales of similar products. An expansion project is one in which new sales are generated. A replacement project is one in which an existing machine is replaced with a more efficient one—new sales might not be created, but cash flows improve because of the more efficient machine.

c. Net operating working capital changes are the increases in current operating assets resulting from accepting a project less the resulting increases in current operating liabilities, or accruals and accounts payable. A net operating working capital change must be financed just as a firm must finance its increases in fixed assets. Salvage value is the market value of an asset after its useful life. Salvage values and their tax effects must be included in project cash flow estimation.

d. Stand-alone risk is the risk a project would have it it were held in isolation. Corporate (within-firm) risk is the risk that a project contributes to a company after taking into consideration the cash flows of the company's other projects; because projects are not perfectly correlated, corporate risk usually will be less than stand-alone risk. Market (beta) risk is the risk that a company contributes to a well diversified portfolio.

e. Sensitivity analysis indicates exactly how much NPV or other output variables such as IRR or MIRR will change in response to a given change in an input variable, other things held constant. Sensitivity analysis is sometimes called "what if" analysis because it answers this type of question. Scenario analysis is a shorter version of simulation analysis that uses only a few outcomes. Often the outcomes considered are optimistic, pessimistic and most likely. Monte Carlo simulation analysis is a risk analysis technique in which a computer is used to simulate probable future events and thus to estimate the profitability and risk of a project.

f. A risk-adjusted discount rate incorporates the risk of the project's cash flows. The cost of capital to the firm reflects the average risk of the firm's existing projects. Thus, new projects that are riskier than existing projects should have a higher risk-adjusted discount rate. Conversely, projects with less risk should have a lower risk-adjusted discount rate. This adjustment process also applies to a firm's divisions. Risk differences are difficult to quantify, thus risk adjustments are often subjective in nature. A project's cost of capital is its risk-adjusted discount rate for that project.

g. A decision tree is a way of structuring a set of sequential decisions that depend on the outcomes at specific points in time. A staged decision tree analysis divides the analysis into different phases. At each phase a decision is made either to proceed or to stop the project. These decisions are represented on the decision trees by circles and are called decision nodes. Each path that depends on a decision is called a branch.

h. Real options occur when managers can influence the size and risk of a project's cash flows by taking different actions during the project's life. They are referred to as real options because they deal with real as opposed to financial assets. They are also called managerial options because they give opportunities to managers to respond to changing market conditions. Sometimes they are called strategic options because they often deal with strategic issues. Finally, they are also called embedded options because they are a part of another project.

i. Investment timing options give companies the option to delay a project rather than implement it immediately. This option to wait allows a company to reduce the uncertainty of market conditions before it decides to implement the project. Capacity options allow a company to change the capacity of their output in response to changing market conditions. This includes the option to contract or expand production. Growth options allow a company to expand if market demand is higher than expected. This includes the opportunity to expand into different geographic markets and the opportunity to introduce complementary or second-generation products. It also includes the option to abandon a project if market conditions deteriorate too much.

11-2 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 chapters we focused on dividends and free cash flows, which represent cash flows, rather than on earnings per share, which represent accounting profits.

11-3 Since the cost of capital includes a premium for expected inflation, failure to adjust cash flows means that the denominator, but not the numerator, rises with inflation, and this lowers the calculated NPV.

11-4 Capital budgeting analysis should only include those cash flows which 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 taking on this project. These cash flows occur only because the firm took on the capital budgeting project; therefore, they must be included in the analysis.

11-5 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. 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 in NOWC, which is treated as an inflow.

11-6 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 $200 million investment in a satellite system than in the decision for the $12,000 truck.

11-7 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.

11-8 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.

11-9 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.

11-10 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 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.

11-11 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.

SOLUTIONS TO END-OF-CHAPTER PROBLEMS

11-1 a.

Equipment	$ 9,000,000
NWC 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 after-tax sale price must be charged against the project as a cost.

11-2 Operating Cash Flows: t = 1

Sales revenues	$10,000,000
Operating costs	7,000,000
Depreciation	2,000,000
Operating income before taxes	$ 1,000,000
Taxes (40%)	400,000
Operating income after taxes	$ 600,000
Add back depreciation	2,000,000
Operating cash flow	$ 2,600,000

11-3

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 net salvage value = $5,000,000 - $400,000 = $4,600,000.

11-4 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, Chen should purchase the new machine.

11-5 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 get operating income, and then taxes due are computed Then, depreciation is added to after-tax operating income 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 income. 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 computed and multiplied by 0.4 to determine the benefit provided by the depreciation expense.

Year	Depreciation Expense Difference (2 – 1)	Depreciation Expense Diff. × 0.4 (MACRS)
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 a straight-line depreciation method.

11-6 a. The net cost is $126,000:

Price	($108,000)
Modification	(12,500)
Increase in NWC	(5,500)
Cash outlay for new machine	($126,000)

b. The operating cash flows follow:

	Year 1	Year 2	Year 3
1. After-tax savings	$28,600	$28,600	$28,600
2. Depreciation tax savings	13,918	18,979	6,326
Net cash flow	$42,518	$47,579	$34,926

Notes:

1. The after-tax cost savings is $44,000(1 - T) = $44,000(0.65) = $28,600.

2. 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. The depreciation tax savings is calculated as the tax rate (35%) times the depreciation expense in each year.

c. The terminal year cash flow is $50,702:

Salvage value	$65,000
Tax on SV*	(19,798)
Return of NWC	5,500
	$50,702

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	Net Cash Flow	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 cash flows on a time line:

0 (12%)	1	2	3
-126,000	42,518	47,579	34,926
			50,702
			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 = $10,841.

11-7 a. The net cost is $89,000:

Price	($70,000)
Modification	(15,000)
Change in NWC	(4,000)
	($89,000)

b. The operating cash flows follow:

	Year 1	Year 2	Year 3
After-tax savings	$15,000	$15,000	$15,000
Depreciation shield	11,220	15,300	5,100
Net cash flow	$26,220	$30,300	$20,100

Notes:

1. The after-tax cost savings is $25,000(1 – T) = $25,000(0.6) = $15,000.
2. The depreciation expense in each year is the depreciable basis, $85,000, times the MACRS allowance percentage of 0.33, 0.45, and 0.15 for Years 1, 2 and 3, respectively. Depreciation expense in Years 1, 2, and 3 is $28,050, $38,250, and $12,750. The depreciation shield is calculated as the tax rate (40%) times the depreciation expense in each year.

c. The additional end-of-project cash flow is $24,380:

Salvage value	$30,000
Tax on SV*	(9,620)
Return of NWC	4,000
	$24,380

*Tax on SV = ($30,000 - $5,950)(0.4) = $9,620.

Note that the remaining BV in Year 4 = $85,000(0.07) = $5,950.

d. The project has an NPV of -$6,705. Thus, it should not be accepted.

Year	Net Cash Flow
0	($89,000)
1	26,220
2	30,300
3	44,480

With a financial calculator, input the following: CF_0 = -89000, CF_1 = 26220, CF_2 = 30300, CF_3 = 44480, and I/YR = 10 to solve for NPV = -$6,703.83.

11-8 a.

Sales = 1,000($138)	$138,000
Cost = 1,000($105)	105,000
Net before tax	$ 33,000
Taxes (34%)	11,220
Net after tax	$ 21,780

Not considering inflation, NPV is -$4,800. This value is calculated as

$$-\$150,000 + \frac{\$21,780}{0.15} = -\$4,800.$$

Considering inflation, the real cost of capital is calculated as follows:

$$(1 + r_r)(1 + i) = 1.15$$
$$(1 + r_r)(1.06) = 1.15$$
$$r_r = 0.0849.$$

Thus, the NPV considering inflation is calculated as

$$-\$150,000 + \frac{\$21,780}{0.0849} = \$106,537.$$

After adjusting for expected inflation, we see that the project has a positive NPV and should be accepted. This demonstrates the bias that inflation can induce into the capital budgeting process: Inflation is already reflected in the denominator (the cost of capital), so it must also be reflected in the numerator.

b. If part of the costs were fixed, and hence did not rise with inflation, then sales revenues would rise faster than total costs. However, when the plant wears out and must be replaced, inflation will cause the replacement cost to jump, necessitating a sharp output price increase to cover the now higher depreciation charges.

11-9 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 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 Taylor would have to pay 0.40($400) = $160 in taxes.
[b] The change in net working capital is a $2,000 increase in current assets minus a $500 increase in current liabilities, 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 Taylor would recover its net 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	1	2	3	4	5	6
(15%)							
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
Working capital 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.

11-10 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.

11-11 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 - $3)^2]$^{0.5}$
= $23.622 million.

$CV_{NPV} = \frac{\$23.622}{\$3.0} = 7.874.$

11-12 a.

	0	1	2	3	4	5
Initial investment	($250,000)					
Net working capital	(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
Oper. inc. before taxes		$ 7,500	($ 22,500)	$52,500	$72,500	$90,000
Taxes (40%)		3,000	(9,000)	21,000	29,000	36,000
Oper. Inc. (AT)		$ 4,500	($ 13,500)	$31,500	$43,500	$54,000
Add: Depreciation		82,500	112,500	37,500	17,500	0
Oper. CF		$87,000	$ 99,000	$69,000	$61,000	$54,000
Return of NWC						$25,000
Sale of Machine						23,000
Tax on sale (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
Initial investment	($250,000)					
Net working capital	(25,000)					
Cost savings		$108,000	$108,000	$108,000	$108,000	$108,000
Depreciation		82,500	112,500	37,500	17,500	0
Oper. inc. before taxes		$ 25,500	($ 4,500)	$ 70,500	$ 90,500	$108,000
Taxes (40%)		10,200	(1,800)	28,200	36,200	43,200
Oper. Inc. (AT)		$ 15,300	($ 2,700)	$ 42,300	$ 54,300	$ 64,800
Add: Depreciation		82,500	112,500	37,500	17,500	0
Oper. CF		$ 97,800	$109,800	$ 79,800	$ 71,800	$ 64,800
Return of NWC						$ 25,000
Sale of Machine						23,000
Tax on sale (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
Initial investment	($250,000)					
Net working capital	(25,000)					
Cost savings		$72,000	$ 72,000	$72,000	$72,000	$72,000

Depreciation		82,500	112,500	37,500	17,500	0
Oper. inc. before taxes		($10,500)	($ 40,500)	$34,500	$54,500	$72,000
Taxes (40%)		(4,200)	(16,200)	13,800	21,800	28,800
Oper. Inc. (AT)		($ 6,300)	($ 24,300)	$20,700	$32,700	$43,200
Add: Depreciation		82,500	112,500	37,500	17,500	0
Oper. CF		$76,200	$ 88,200	$58,200	$50,200	$43,200
Return of NWC						$25,000
Sale of Machine						23,000
Tax on sale (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
Initial investment	($250,000)					
Net working capital	(30,000)					
Cost savings		$72,000	$ 72,000	$72,000	$72,000	$72,000
Depreciation		82,500	112,500	37,500	17,500	0
Oper. inc. before taxes		($10,500)	($ 40,500)	$34,500	$54,500	$72,000
Taxes (40%)		(4,200)	(16,200)	13,800	21,800	28,800
Oper. Inc. (AT)		($ 6,300)	($ 24,300)	$20,700	$32,700	$43,200
Add: Depreciation[a]		82,500	112,500	37,500	17,500	0
Oper. CF		$76,200	$ 88,200	$58,200	$50,200	$43,200
Return of NWC						$30,000
Sale of Machine						18,000
Tax on sale (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
Initial investment	($250,000)					
Net working capital	(20,000)					
Cost savings		$108,000	$108,000	$108,000	$108,000	$108,000
Depreciation		82,500	112,500	37,500	17,500	0
Oper. inc. before taxes		$ 25,500	($ 4,500)	$ 70,500	$ 90,500	$108,000

Taxes (40%)		10,200	(1,800)	28,200	36,200	43,200
Oper. Inc. (AT)		$ 15,300	($ 2,700)	$ 42,300	$ 54,300	$ 64,800
Add: Depreciation[a]		82,500	112,500	37,500	17,500	0
Oper. CF		$ 97,800	$109,800	$ 79,800	$ 71,800	$ 64,800
Return of NWC						$ 20,000
Sale of Machine						28,000
Tax on sale (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.

11-13 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)

$$CF_t = (\Delta\text{Operating expenses})(1 - T) + (\Delta\text{Depreciation})(T).$$

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

c.

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

NPV = $34,073.20

Therefore, the firm should replace the old machine.

*After-tax opportunity cost of not being able to sell old machine at end of its useful life.

11-14 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. $$CF_t = (\Delta\text{Operating expenses})(1 - T) + (\Delta\text{Depreciation})(T).$$

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

d. A time line of the cash flows looks like this:

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

NPV = $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.

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

Book value = 0.06($1,175,000) = $70,500.
Gain = $145,000 – $70,500 = $74,500.
Tax = 0.35($74,500) = $26,075.
AT salvage value of new machine = $145,000 – $26,075 = $118,925.

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.

11-15 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 percent cost of capital, while Project A requires only a 10 percent cost of capital.

Project A: With a financial calculator, input the appropriate cash flows into the cash flow register, input I/YR = 10, and then solve for NPV = $10,036.25.

Project B: With a financial calculator, input the appropriate cash flows into the cash flow register, input I = 12, and then solve for NPV = $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.

11-16 a. First, note that with symmetric probability distributions, the middle value of each distribution is the expected value. Therefore,

	Expected Values	
Sales (units)	200	
Sales price	$13,500	
Sales in dollars	$2,700,000	
Costs (200 x $6,000)	1,200,000	
Earnings before taxes	$1,500,000	
Taxes (40%)	600,000	
Net income	$ 900,000	=Cash flow under the assumption used in the problem.

$$0 = \sum_{t=1}^{8} \frac{\$900{,}000}{(1+\text{IRR})^t} - \$4{,}000{,}000.$$

Using a financial calculator, input the following: CF_0 = -4000000, CF_1 = 900000, and N_j = 8, to solve for IRR = 15.29%.

Expected IRR = 15.29% ≈ 15.3%.

Assuming complete independence between the distributions, and normality, it would be possible to derive σ_{IRR} statistically. Alternatively, we could employ simulation to develop a distribution of IRRs, hence σ_{IRR}. There is no easy way to get σ_{IRR}.

b. Using a financial calculator, input the following: CF_0 = -4000000, CF_1 = 900000, N_j = 8, and I/YR = 15 to solve for NPV = $38,589.36. Again, there is no easy way to estimate σ_{NPV}.

c. (1) a. Calculate developmental costs. The 44 random number value, coming between 30 and 70, indicates that the costs for this run should be taken to be $4 million.

b. Calculate the project life. The 17, being less than 20, indicates that a 3-year life should be used.

(2) a. Estimate unit sales. The 16 indicates sales of 100 units.

b. Estimate the sales price. The 58 indicates a sales price of $13,500.

c. Estimate the cost per unit. The 1 indicates a cost of $5,000.

d. Now estimate the after-tax cash flow for Year 1. It is

$$[100(\$13,500) - 100(\$5,000)](1 - 0.4) = \$510,000 = CF_1.$$

(3) Repeat the process for Year 2. Sales will be 200 with a random number of 79; the price will be $13,500 with a random number of 83; and the cost will be $7,000 with a random number of 86:

$$[200(\$13,500) - 200(\$7,000)](0.6) = \$780,000 = CF_2.$$

(4) Repeat the process for Year 3. Sales will be 100 units with a random number of 19; the price will be $13,500 with a random number of 62; and the cost will be $5,000 with a random number of 6:

$$[100(\$13,500) - 100(\$5,000)](0.6) = \$510,000 = CF_3.$$

(5) a. $$0 = \frac{\$510,000}{(1+IRR)^1} + \frac{\$780,000}{(1+IRR)^2} + \frac{\$510,000}{(1+IRR)^3} - \$4,000,000$$

IRR = -31.55%.

Alternatively, with a financial calculator, input the following: CF_0 = -4000000, CF_1 = 510000, CF_2 = 780000, CF_3 = 510000, and solve for IRR = -31.55%.

b. $$NPV = \frac{\$510,000}{(1.15)^1} + \frac{\$780,000}{(1.15)^2} + \frac{\$510,000}{(1.15)^3} - \$4,000,000.$$

With a financial calculator, input the following: CF_0 = -4000000, CF_1 = 510000, CF_2 = 780000, CF_3 = 510000, and I/YR = 15 to solve for NPV = -$2,631,396.40.

The results of this run are very bad because the project's life is so short. Had the life turned out (by chance) to be 13 years, the longest possible life, the IRR would have been about 25%, and the NPV would have been about $1 million.

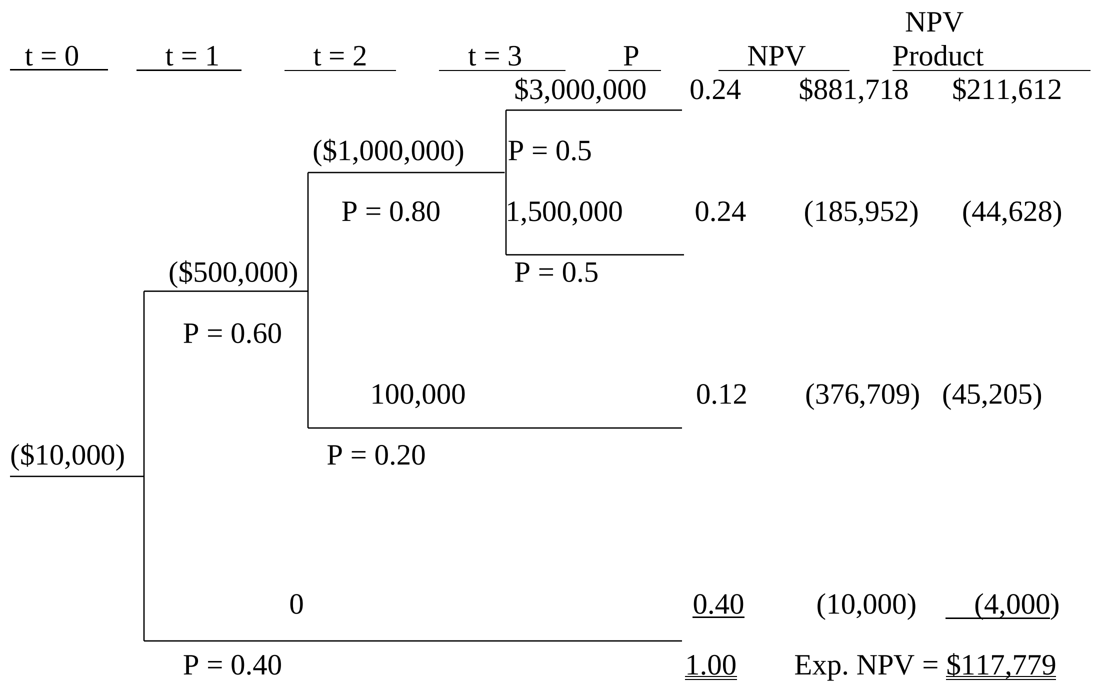
(6) & (7) The computer would store σ_{NPVs} and σ_{IRRs} for the different trials, then display them as frequency distributions:

```
       Probability
      of occurrence

             X
            XX
           XXXX
         XXXXXXXX
     XXXXXXXXXXXXXXXX
   XXXXXXXXXXXXXXXXXXXX
_________________________
0  E(NPV)             NPV
```

```
       Probability
      of occurrence

             X
            XX
           XXXX
         XXXXXXXX
     XXXXXXXXXXXXXXXX
   XXXXXXXXXXXXXXXXXXXX
_________________________
0  E(NPV)             NPV
```

The distribution would be reasonably symmetrical because all the input data were from symmetrical distributions. One often finds, however, that the input and output distributions are badly skewed. The frequency values would also be used to calculate σ_{NPV} and σ_{IRR}; these values would be printed out and available for analysis.

11-17 a. The resulting decision tree is:



The NPV of the top path is:

$$\frac{\$3{,}000{,}000}{(1.12)^3} - \frac{\$1{,}000{,}000}{(1.12)^2} - \frac{\$500{,}000}{(1.12)^1} - \$10{,}000 = \$881{,}718.$$

Using a financial calculator, input the following: CF_0 = -10000, CF_1 = -500000, CF_2 = -1000000, CF_3 = 3000000, and I/YR = 12 to solve for NPV = $881,718.29 ≈ $881,718.

The other NPVs were determined in the same manner. If the project is of average risk, it should be accepted because the expected NPV of the total project is positive.

b. σ^2_{NPV}= 0.24(\$881,718 - \$117,779)^2 + 0.24(-\$185,952 - \$117,779)^2
+ 0.12(-\$376,709 - \$117,779)^2 + 0.4(-\$10,000 - \$117,779)^2
= 198,078,470,853.

σ_{NPV} = $445,060.

$$CV_{NPV} = \frac{\$445{,}060}{\$117{,}779} = 3.78.$$

Since the CV is 3.78 for this project, while the firm’s average project has a CV of 1.0 to

2.0, this project is of high risk.