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 if it was 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 Scenario analysis analyzes a limited number of outcomes. Although the base case scenario may be the most likely, or expected outcome, the bad and good scenarios are frequently worst case and best case scenarios, that is, when everything goes bad together, or everything goes right together. It is unlikely that everything will go wrong all at once, or everything will go right all at once and so scenario analysis can tend to overestimate the riskiness of a project. Simulation analysis, on the other hand, allows the variables being simulated to either vary together or independently, as the modeler sees fit. With enough runs of the simulation, this procedure should provide a reasonably accurate description of the possible outcomes. Note, however, that if the project is big and its failure could threaten the viability of the firm, then evaluating a worst case scenario may very well be important! A simulation may only identify that worst case outcome infrequently and with a scenario analysis you can specify the worst case and see if it drags the company down.

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 $ 17,000,000

NWC Investment 5,000,000

Initial investment outlay $22,000,000

b. No, last year’s $150,000 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 $18,000,000

Operating costs 9,000,000

Depreciation 4,000,000

Operating income before taxes $ 5,000,000

Taxes (40%) 2,000,000

Operating income after taxes $ 3,000,000

Add back depreciation 4,000,000

Operating cash flow $ 7,000,000

11-3 Equipment's original cost $12,000,000

Depreciation (80%) 9,000,000

Book value $ 3,000,000

Gain on sale = $4,000,000 - $3,000,000 = $1,000,000.

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

AT net salvage value = $4,000,000 - $400,000 = $3,600,000.

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 1 2 10

| | | • • • |

10%

-110,000 19,000 19,000 19,000

With a financial calculator, input the appropriate cash flows into the cash flow register, input I/YR = 10, and then solve for NPV = $6,746.78. Thus, Chen should purchase the new machine.

11-5 a. The MACRS rates are 33.33%, 44.45%, 14.81%, and 7.41%. The first MACRS depreciation expense is 33.33%($1,700,000) = $566,610. The others are calculated similarly. The applicable depreciation values are as follows for the two scenarios:

Scenario 1 Scenario 2

Year (Straight Line) (MACRS)

1 $425,000 $566,610

2 425,000 755,650

3 425,000 251,770

4 425,000 125,970

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.

Depreciation Expense Depreciation Expense

Year Difference (2 – 1) Diff. × 0.4 (MACRS)

1 $141,610 $56,644

2 330,650 132,260

3 -173,230 -69,292

4 -299,030 -119,612

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%.

CF0 = 0; CF1 = 56644; CF2 = 132260; CF3 = -69292; CF4 = -119612; and I/YR = 10. Solve for NPV = $27,043.62

So, all else equal the use of the accelerated depreciation method will result in a higher NPV (by $27,043.62) than would the use of a straight-line depreciation method.

c. If Wendy’s boss has a bonus plan that depends on net income instead of cash flow, then he will make a larger bonus in the first 2 years of the project if they use straight line depreciation, and a smaller bonus in the last two years. This is despite the fact that accelerated depreciation is better economically for the firm. The fault lies in the bonus plan. Paying managers a bonus based on net income can lead to decisions that are not in the best interest of the company’s shareholders, like this one.

11-6 a. The net cost is $1,118,000:

Price ($1,080,000)

Modification (22,500)

Increase in NWC (15,500)

Cash outlay for new machine ($1,118,000)

b. The operating cash flows follow:

Year 1 Year 2 Year 3

1. After-tax savings $247,000 $247,000 $28,600

2. Depreciation tax savings 128,612 171,521 57,148

Net cash flow $375,612 $418,512 $304,148

Notes:

1. The after-tax cost savings is $380,000(1 - T) = $380,000(0.65)

= $247,000

2. The depreciation expense in each year is the depreciable basis, $1,102,500, times the MACRS allowance percentages of 0.3333, 0.4445, and 0.1481 for Years 1, 2, and 3, respectively. Depreciation expense in Years 1, 2, and 3 is $367,463, $490,061, and $163,280. 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 $473,343:

Salvage value $605,000

Tax on SV\* (183,157)

Return of NWC 15,500

$437,343

BV in Year 4 = $1,102,500(0.0741) = $81,695.

\*Tax on SV = ($605,000 - $81,695)(0.35) = $183,157.

d. The project has an NPV of $78,790; thus, it should be accepted.

Year Net Cash Flow PV @ 12%

0 ($1,118,000) ($1,118,000)

1 375,612 335,368

2 418,512 333,643

3 741,491 527,779

NPV = $ 78,790

Alternatively, with a financial calculator, input the appropriate cash flows into the cash flow register, input I/YR = 12, and then solve for NPV = $78,790.

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 11,332 15,113 5,035

Net cash flow $26,332 $30,113 $20,035

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 0.3333, 0.4445, and 0.1481 for Years 1, 2 and 3, respectively. Depreciation expense in Years 1, 2, and 3 is $28,331, $37,783, and $12.589. 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 $24,519:

Salvage value $30,000

Tax on SV\*  (9,481)

Return of NWC 4,000

$24,519

\*Tax on SV = ($30,000 - $6,299)(0.4) = $9,481.

Note that the remaining BV in Year 4 = $85,000(0.0741) = $6299.

d. The project has an NPV of -$6,700. Thus, it should not be accepted.

Year Net Cash Flow

0 ($89,000)

1 26,332

2 30,113

3 44,555

With a financial calculator, input the following: CF0 = -89000, CF1 = 26332, CF2 = 30113, CF3 = 44555, and I/YR = 10 to solve for NPV = -$6,700.18.

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 +  = -$4,800.

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

(1 + rr)(1 + i) = 1.15

(1 + rr)(1.06) = 1.15

rr = 0.0849057.

Thus, the NPV considering inflation is calculated as

-$150,000 + = $106,520.

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.

A more straightforward way to calculate the present value without having to calculate a real required rate of return is to use the constant growth formula, instead. Here, the present value of all of the future cash flows is:

so the NPV = 256,520 – 150,000 = 106,520, which is the same answer we’d have gotten above if in calculating the real required rate of return we had used enough decimal places.

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. Note that if you wanted to value this perpetuity with a fixed component and a growing component, the total cash flows would no longer grow at a constant rate and so the constant growth formula couldn’t be used as we did in part (a). Instead, you would need to either calculate a real required rate of return, as we did in the first part of the solution to (a), or better, split the cash flows into two parts: a growing part that grows at 6% and a non-growing part. Use the constant growth formula on the growing part with g = 6%, and use the constant growth formula on the non-growing part with g = 0%.

11-9 First determine the net cash flow at t = 0:

Purchase price ($12,000)

Sale of old machine 4,150

Tax on sale of old machine (240)a

Change in net working capital (2,200)b

Total investment ($10,290)

a The market value is $4,150 – $3,550 = $600 above the book value. Thus, there is a $600 recapture of depreciation, and Taylor would have to pay 0.40($600) = $240 in taxes.

b The change in net working capital is a $2,900 increase in current assets minus a $700 increase in current liabilities, which totals to $2,200.

Now, examine the annual cash inflows:

Sales increase $2,000

Cost decrease 1,900

Increase in pre-tax revenues $3,900

After-tax revenue increase:

$3,900(1 – T) = $3,900(0.60) = $2,340.

Depreciation:

Year 1 2 3 4 5 6

Newa $2,400 $8,840 $2,304 $1,382 $1,382 $691

Old 650 650 650 650 650 325

Change $1,750 $3,190 $1,654 $732 $732 $366

Depreciation tax savingsb $ 700 $ 1,276 $ 662 $293 $293 $ 146

a Depreciable basis = $12,000. Depreciation expense in each year equals depreciable basis times the MACRS percentage allowances of 0.2000, 0.3200, 0.1920, 0.1152, 0.1152, and 0.0576 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 $2,200, and it would also receive $1,500 from the sale of the replacement machine. However, since the machine would be fully depreciated, the firm must pay 0.40($1,500) = $600 in taxes on the sale. Also, by undertaking the replacement now, the firm forgoes the right to sell the old machine for $800 in Year 6; thus, this $800 in Year 6 must be considered an opportunity cost in that year. Taxes of $800(0.4) = 320 would be due because the old machine would be fully depreciated in Year 6, so the opportunity cost of the old machine would be $800 – $320 = $480.

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

0 1 2 3 4 5 6

15%

| | | | | | |

Net investment (10290)

After-tax revenue increase 2,340 2,340 2,340 2,340 2,340 2,340

Depreciation tax savings 700 1,276 662 293 293 146

Working capital recovery 2,200

Salvage value of new machine 1,500

Tax on salvage value of

new machine (600)

Opportunity cost of

old machine (480)

Project cash flows (10,290) 3,040 3,616 3,002 2,633 2,633 5,106

The net present value of this incremental cash flow stream, when discounted at 15%, is $2,083.51. Thus, the replacement should be made.

11-10 1. Net investment at t = 0:

Cost of new machine $182,500

Net investment outlay (CF0) $182,500

2. After-tax

Year Earnings T(ΔDep) Annual CFt

1 $28,200 $ 14,600 $42,800

2 28,200 23,360 51,560

3 28,200 14,016 42,216

4 28,200 8,410 36,610

5 28,200 8,410 36,610

6 28,200 4,205 32,405

7 28,200 0 28,200

8 28,200 0 28,200

Notes:

a. The after-tax earnings are $47,000(1 – T) = $47,000(0.6) = $28,200.

b. Find ΔDep over Years 1-8:

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

Dep Dep

Year Rate Basis Depreciation

1 0.2000 $182,500 $36,500

2 0.3200 182,500 58,400

3 0.1920 182,500 35,040

4 0.1152 182,500 21,024

5 0.1152 182,500 21,024

6 0.0576 182,500 10,512

7-8 0.00 182,500 0

3. Now find the NPV of the replacement machine:

Place the cash flows on a time line:

0 1 2 3 4 5 6 7 8

| | | | | | | | |

12%

-182,500 42,800 51,560 42,216 36,610 36,610 32,405 28,200 28,200

With a financial calculator, input the appropriate cash flows into the cash flow register, input I/YR = 12, and then solve for NPV = $11,468.48. 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.

σNPV = [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.

CVNPV =  = 7.874.

11-12 a.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | 0 | 1 | 2 | 3 | 4 | 5 |
| Machine cost | (350,000) |  |  |  |  |  |
| Net working capital | (35,000) |  |  |  |  |  |
|  |  |  |  |  |  |  |
| Cost savings |  | 110,000 | 110,000 | 110,000 | 110,000 | 110,000 |
| Depreciation |  | 116,655 | 155,575 | 51,835 | 25,935 | - |
| Op. Inc. before taxes |  | (6,655) | (45,575) | 58,165 | 84,065 | 110,000 |
| Taxes |  | (2,662) | (18,230) | 23,266 | 33,626 | 44,000 |
| A-T operating income |  | (3,993) | (27,345) | 34,899 | 50,439 | 66,000 |
| Add depreciation |  | 116,655 | 155,575 | 51,835 | 25,935 | - |
| Operating CF |  | 112,662 | 128,230 | 86,734 | 76,374 | 66,000 |
|  |  |  |  |  |  |  |
| Return of NWC |  |  |  |  |  | 35,000 |
| Sale of machine |  |  |  |  |  | 33,000 |
| Tax on sale |  |  |  |  |  | (13,200) |
| Total CF | (385,000) | 112,662 | 128,230 | 86,734 | 76,374 | 120,800 |
| NPV | 15,732 |  |  |  |  |  |
| IRR | 11.64% |  |  |  |  |  |
| MIRR | 10.88% |  |  |  |  |  |
| Cumulative CF | (385,000) | (272,338) | (144,108) | (57,374) | 19,000 | 139,800 |
| Payback | 3.75 |  |  |  |  |  |

Notes:

a Depreciation Schedule, Basis = $250,000

MACRS Rate

× Basis =

Year Beg. Bk. Value MACRS Rate Depreciation Ending BV

1 $350,000 0.3333 $ 116,665 $233,345

2 233,345 0.4445 155,575 77,770

3 77,770 0.1481 51,835 29,935

4 25,935 0.0741 25,935 0

$350,000

b. If savings increase by 20%, then savings will be (1.2)($110,000) = $132,000.

If savings decrease by 20%, then savings will be (0.8)($110,000) = $88,000.

(1) Savings increase by 20%:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | 0 | 1 | 2 | 3 | 4 | 5 |
| Machine cost | (350,000) |  |  |  |  |  |
| Net working capital | (35,000) |  |  |  |  |  |
|  |  |  |  |  |  |  |
| Cost savings |  | 132,000 | 132,000 | 132,000 | 132,000 | 132,000 |
| Depreciation |  | 116,655 | 155,575 | 51,835 | 25,935 | - |
| Op. Inc. before taxes |  | 15,345 | (23,575) | 80,165 | 106,065 | 132,000 |
| Taxes |  | 6,138 | (9,430) | 32,066 | 42,426 | 52,800 |
| A-T operating income |  | 9,207 | (14,145) | 48,099 | 63,639 | 79,200 |
| Add depreciation |  | 116,655 | 155,575 | 51,835 | 25,935 | - |
| Operating CF |  | 125,862 | 141,430 | 99,934 | 89,574 | 79,200 |
|  |  |  |  |  |  |  |
| Return of NWC |  |  |  |  |  | 35,000 |
| Sale of machine |  |  |  |  |  | 33,000 |
| Tax on sale |  |  |  |  |  | (13,200) |
| Total CF | (385,000) | 125,862 | 141,430 | 99,934 | 89,574 | 134,000 |
| NPV | 65,770 |  |  |  |  |  |
| IRR | 16.67% |  |  |  |  |  |
| MIRR | 13.53% |  |  |  |  |  |
| Cumulative CF | (385,000) | (259,138) | (117,708) | (17,774) | 71,800 | 205,800 |
| Payback | 3.20 |  |  |  |  |  |

(2) Savings decrease by 20%:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | 0 | 1 | 2 | 3 | 4 | 5 |
| Machine cost | (350,000) |  |  |  |  |  |
| Net working capital | (35,000) |  |  |  |  |  |
|  |  |  |  |  |  |  |
| Cost savings |  | 88,000 | 88,000 | 88,000 | 88,000 | 88,000 |
| Depreciation |  | 116,655 | 155,575 | 51,835 | 25,935 | - |
| Op. Inc. before taxes |  | (28,655) | (67,575) | 36,165 | 62,065 | 88,000 |
| Taxes |  | (11,462) | (27,030) | 14,466 | 24,826 | 35,200 |
| A-T operating income |  | (17,193) | (40,545) | 21,699 | 37,239 | 52,800 |
| Add depreciation |  | 116,655 | 155,575 | 51,835 | 25,935 | - |
| Operating CF |  | 99,462 | 115,030 | 73,534 | 63,174 | 52,800 |
|  |  |  |  |  |  |  |
| Return of NWC |  |  |  |  |  | 35,000 |
| Sale of machine |  |  |  |  |  | 33,000 |
| Tax on sale |  |  |  |  |  | (13,200) |
| Total CF | (385,000) | 99,462 | 115,030 | 73,534 | 63,174 | 107,600 |
| NPV | (34,307) |  |  |  |  |  |
| IRR | 6.33% |  |  |  |  |  |
| MIRR | 7.97% |  |  |  |  |  |
| Cumulative CF | (385,000) | (285,538) | (170,508) | (96,974) | (33,800) | 73,800 |
| Payback | 4.31 |  |  |  |  |  |

c. Worst-case scenario:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | 0 | 1 | 2 | 3 | 4 | 5 |
| Machine cost | (350,000) |  |  |  |  |  |
| Net working capital | (40,000) |  |  |  |  |  |
|  |  |  |  |  |  |  |
| Cost savings |  | 88,000 | 88,000 | 88,000 | 88,000 | 88,000 |
| Depreciation |  | 116,655 | 155,575 | 51,835 | 25,935 | - |
| Op. Inc. before taxes |  | (28,655) | (67,575) | 36,165 | 62,065 | 88,000 |
| Taxes |  | (11,462) | (27,030) | 14,466 | 24,826 | 35,200 |
| A-T operating income |  | (17,193) | (40,545) | 21,699 | 37,239 | 52,800 |
| Add depreciation |  | 116,655 | 155,575 | 51,835 | 25,935 | - |
| Operating CF |  | 99,462 | 115,030 | 73,534 | 63,174 | 52,800 |
|  |  |  |  |  |  |  |
| Return of NWC |  |  |  |  |  | 40,000 |
| Sale of machine |  |  |  |  |  | 28,000 |
| Tax on sale |  |  |  |  |  | (11,200) |
| Total CF | (390,000) | 99,462 | 115,030 | 73,534 | 63,174 | 109,600 |
| NPV | (38,065) |  |  |  |  |  |
| IRR | 5.99% |  |  |  |  |  |
| MIRR | 7.76% |  |  |  |  |  |
| Cumulative CF | (390,000) | (290,538) | (175,508) | (101,974) | (38,800) | 70,800 |
| Payback | 4.35 |  |  |  |  |  |

Base-case scenario:

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

Best-case scenario:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | 0 | 1 | 2 | 3 | 4 | 5 |
| Machine cost | (350,000) |  |  |  |  |  |
| Net working capital | (30,000) |  |  |  |  |  |
|  |  |  |  |  |  |  |
| Cost savings |  | 132,000 | 132,000 | 132,000 | 132,000 | 132,000 |
| Depreciation |  | 116,655 | 155,575 | 51,835 | 25,935 | - |
| Op. Inc. before taxes |  | 15,345 | (23,575) | 80,165 | 106,065 | 132,000 |
| Taxes |  | 6,138 | (9,430) | 32,066 | 42,426 | 52,800 |
| A-T operating income |  | 9,207 | (14,145) | 48,099 | 63,639 | 79,200 |
| Add depreciation |  | 116,655 | 155,575 | 51,835 | 25,935 | - |
| Operating CF |  | 125,862 | 141,430 | 99,934 | 89,574 | 79,200 |
|  |  |  |  |  |  |  |
| Return of NWC |  |  |  |  |  | 30,000 |
| Sale of machine |  |  |  |  |  | 38,000 |
| Tax on sale |  |  |  |  |  | (15,200) |
| Total CF | (380,000) | 125,862 | 141,430 | 99,934 | 89,574 | 132,000 |
| NPV | 69,528 |  |  |  |  |  |
| IRR | 17.15% |  |  |  |  |  |
| MIRR | 13.76% |  |  |  |  |  |
| Cumulative CF | (380,000) | (254,138) | (112,708) | (12,774) | 76,800 | 208,800 |
| Payback | 3.14 |  |  |  |  |  |

Prob. NPV Prob. × NPV

Worst-case 0.35 ($ 38,065) ($ 13,323)

Base-case 0.35 15,732 5,506

Best-case 0.30 69,528 20,858

E(NPV) $13,041

σNPV = [(0.35)(-$38,065 – $13,041)2 + (0.35)($15,732 – $13,041)2 + (0.30)($69,528 – $13,041)2]½

= [$914,163,732 + $2,532,310 + $957,212,993]½

= $43,289.

CV = $43,289/13,041 = 3.32.

11-13 a. Old depreciation = $5,500 per year.

Book value = $55,000 – 5($5,500) = $27,500.

Gain = $35,000 – $27,500 = $7,500.

Tax on book gain = $7,500(0.35) = $2,625.

Price ($55,000)

SV (old machine) 35,000

Tax effect (2,625)

Initial outlay ($ 87,625)

b.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  | 1 | 2 | 3 | 4 | 5 |
| Old depreciation |  | 5,500 | 5,500 | 5,500 | 5,500 | 5,500 |
| Old tax shield |  | 1,925 | 1,925 | 1,925 | 1,925 | 1,925 |
| Basis | 120,000 |  |  |  |  |  |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| MACRS Rate |  | 33.33% | 44.45% | 14.81% | 7.41% | 0.00% |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| New depreciation |  | 39,996 | 53,340 | 17,772 | 8,892 | - |
| New tax shield |  | 13,999 | 18,669 | 6,220 | 3,112 | - |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | 0 | 1 | 2 | 3 | 4 | 5 |
| After tax savings |  | 19,500 | 19,500 | 19,500 | 19,500 | 19,500 |
| Depreciation tax shield new | | 13,999 | 18,669 | 6,220 | 3,112 | - |
| Depreciation tax shield old | | (1,925) | (1,925) | (1,925) | (1,925) | (1,925) |
| Opportunity cost of not selling old machine (after-tax)\* | | | | |  | (13,000) |
| Total CF | (87,625) | 31,574 | 36,244 | 23,795 | 20,687 | 4,575 |
| c. NPV | (4,623) |  |  |  |  |  |

The NPV is negative therefore, the firm should not 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 ($775,000)

Salvage value, old 135,000

Savings due to loss on sale ($450,000 – $135,000) × 0.35 110,250

Cash outlay for new machine ($ 529,750)

b. Recovery Depreciable Depreciation Depreciation Change in

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  | 1 | 2 | 3 | 4 | 5 |
| Old depreciation |  | 90,000 | 90,000 | 90,000 | 90,000 | 90,000 |
| Old tax shield |  | 31,500 | 31,500 | 31,500 | 31,500 | 31,500 |
| Basis | 775,000 |  |  |  |  |  |
| MACRS depreciation rate | | 20.00% | 32.00% | 19.20% | 11.52% | 11.52% |
| New depreciation |  | 155,000 | 248,000 | 148,800 | 89,280 | 89,280 |
| New tax shield |  | 54,250 | 86,800 | 52,080 | 31,248 | 31,248 |
| Incremental depreciation | | 65,000 | 158,000 | 58,800 | (720) | (720) |
| Incremental depreciation tax shield | | 22,750 | 55,300 | 20,580 | (252) | (252) |

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

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | 0 | 1 | 2 | 3 | 4 | 5 |
| After tax cost savings |  | 120,250 | 120,250 | 120,250 | 120,250 | 120,250 |
| Incremental Depreciation tax shield | | 22,750 | 55,300 | 20,580 | (252) | (252) |
| Salvage value |  |  |  |  |  | 83,874 |
| Total CF | (529,750) | 143,000 | 175,550 | 140,830 | 119,998 | 203,872 |
| NPV | 30,059 |  |  |  |  |  |

\*The salvage value of the new machine is calculated as: Book value = 7.41%(775,000) = 44,460. The tax effect is -(105,000 – 44,660)(0.35) = (21,126) so the after-tax salvage cash flow is 105,000 – 21,126 = 83,874.

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

0 1 2 3 4 5

| | | | | |

12%

(529,750) 143,000 175,550 140,830 119,998 203,872

NPV = $30,059

Since the NPV is positive, the project should be accepted. To buy the new machine would increase the value of the firm by $30,059.

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: Probable

Probability × Cash Flow = 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: Probable

Probability × Cash Flow = 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 = 

Project A:

σA = 

Project B:

σB = 

= $5,797.84.

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

CVB = $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 =  - $4,000,000.

Using a financial calculator, input the following: CF0 = -4000000, CF1 = 900000, and Nj = 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 σIRR statistically. Alternatively, we could employ simulation to develop a distribution of IRRs, hence σIRR. There is no easy way to get σIRR.

b. Using a financial calculator, input the following: CF0 = -4000000, CF1 = 900000, Nj = 8, and I/YR = 15 to solve for NPV = $38,589.36. Again, there is no easy way to estimate σNPV.

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 = CF1.

(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 = CF2.

(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 = CF3.

(5) a. 0 =  - $4,000,000

IRR = -31.55%.

Alternatively, with a financial calculator, input the following: CF0 = -4000000, CF1 = 510000, CF2 = 780000, CF3 = 510000, and solve for IRR = -31.55%.

b. NPV =  - $4,000,000.

With a financial calculator, input the following: CF0 = -4000000, CF1 = 510000, CF2 = 780000, CF3 = 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 σNPVs and σIRRs for the different trials, then display them as frequency distributions:

Probability

of occurrence

X

XX

XXXX

XXXXXXXX

XXXXXXXXXXXXXXX

XXXXXXXXXXXXXXXXXXX

0 E(NPV) NPV

Probability

of occurrence

X

XX

XXXX

XXXXXXXX

XXXXXXXXXXXXXXX

XXXXXXXXXXXXXXXXXXX

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 σNPV and σIRR; these values would be printed out and available for analysis.

11-17 a. The resulting decision tree is:

NPV

t = 0 t = 1 t = 2 t = 3 P NPV Product

$3,000,000 0.24 $881,718 $211,612

($1,000,000) P = 0.5

P = 0.80 1,500,000 0.24 (185,952) (44,628)

($500,000) P = 0.5

P = 0.60

100,000 0.12 (376,709) (45,205)

($10,000) P = 0.20

0 0.40 (10,000) (4,000)

P = 0.40 1.00 Exp. NPV = $117,779

The NPV of the top path is:

 -  -  - $10,000 = $881,718.

Using a financial calculator, input the following: CF0 = -10000,   
CF1 = -500000, CF2 = -1000000,  = 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. σ2NPV = 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.

σNPV = $445,060.

CVNPV =  = 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.

###### SOLUTION TO SPREADSHEET PROBLEM

11-18 The detailed solution for the problem is available in the file ***Ch 11 P18 Build a Model Solution.xls*** at the textbook’s Web site.

## **MINI CASE**

**Shrieves Casting Company is considering adding a new line to its product mix, and the capital budgeting analysis is being conducted by Sidney Johnson, a recently graduated MBA. The production line would be set up in unused space in Shrieves’ main plant. The machinery’s invoice price would be approximately $200,000, another $10,000 in shipping charges would be required, and it would cost an additional $30,000 to install the equipment. The machinery has an economic life of 4 years, and Shrieves has obtained a special tax ruling that places the equipment in the MACRS 3-year class. The machinery is expected to have a salvage value of $25,000 after 4 years of use.**

**The new line would generate incremental sales of 1,250 units per year for 4 years at an incremental cost of $100 per unit in the first year, excluding depreciation. Each unit can be sold for $200 in the first year. The sales price and cost are expected to increase by 3% per year due to inflation. Further, to handle the new line, the firm’s net working capital would have to increase by an amount equal to 12% of sales revenues. The firm’s tax rate is 40%, and its overall weighted average cost of capital is 10%.**

a. Define “incremental cash flow.”

**Answer:** This is the firm’s cash flow with the project minus the firm’s cash flow without the project.

**a. 1. Should you subtract interest expense or dividends when calculating project cash flow?**

**Answer:** The cash flow statement should not include interest expense or dividends. The return required by the investors furnishing the capital is already accounted for when we apply the 10% cost of capital discount rate; hence, including financing flows would be “double counting.” Put another way, if we deducted capital costs in the table, and thus reduced the bottom-line cash flows, and then discounted those CFs by the cost of capital, we would, in effect, be subtracting capital costs twice.

**a. 2. Suppose the firm had spent $100,000 last year to rehabilitate the production line site. Should this cost be included in the analysis? Explain.**

**Answer:** The $100,000 cost to rehabilitate the production line site was incurred last year, and presumably also expensed for tax purposes. Since, it is a sunk cost, it should not be included in the analysis.

**a. 3. Now assume that the plant space could be leased out to another firm at $25,000 per year. Should this be included in the analysis? If so, how?**

**Answer:** If the plant space could be leased out to another firm, then if Shrieves accepts this project, it would forgo the opportunity to receive $25,000 in annual cash flows. This represents an opportunity cost to the project, and it should be included in the analysis. Note that the opportunity cost cash flow must be net of taxes, so it would be a $25,000(1 – T) = $25,000(0.6) = $15,000 annual outflow.

**a. 4. Finally, assume that the new product line is expected to decrease sales of the firm’s other lines by $50,000 per year. Should this be considered in the analysis? If so, how?**

**Answer:** If a project affects the cash flows of another project, this is an “externality” that must be considered in the analysis. If the firm's sales would be reduced by $50,000, then the net cash flow loss would be a cost to the project. Note that this annual loss would not be the full $50,000, because Shrieves would save on cash operating costs if its sales dropped. Note also that externalities can be positive as well as negative.

**b. Disregard the assumptions in part a. What is Shrieves’ depreciable basis? What are the annual depreciation expenses?**

**Answer:** The asset’s depreciable basis includes shipping and installation costs. Thus, the asset’s depreciable basis = $200,000 + $10,000 + $30,000 = $240,000. Get the depreciation rates from Table 11A-2 in the book. Note that because of the half-year convention, a 3‑year project is depreciated over 4 calendar years:

(Dollars in Thousands)

Year Rate × Basis = Depreciation

1 0.3333 $240 $ 80

2 0.4445 240 107

3 0.1481 240 35

4 0.0741 240 18

$240

**c. Calculate the annual sales revenues and costs (other than depreciation). Why is it important to include inflation when estimating cash flows?**

**Answer:** With an inflation rate of 3%, the annual revenues and costs are:

Year 1 Year 2 Year 3 Year 4

Units 1,250 1,250 1,250 1,250

Unit Price $200.00 $206.00 $212.18 $218.55

Unit Cost $100.00 $103.00 $106.09 $109.27

Sales $250,000 $257,500 $265,225 $273,188

Costs $125,000 $128,750 $132,613 $136,588

The cost of capital is a nominal cost; i.e., it includes a premium for inflation. In other words, it is larger than the real cost of capital. Similarly, nominal cash flows (those that are inflated) are larger than real cash flows. If you discount the low, real cash flows with the high, nominal rate, then the resulting NPV is too low. Therefore, you should always discount nominal cash flows with a nominal rate, and real cash flows with a real rate. In theory, you could do the analysis either way and obtain the correct answer. However, there is no accurate way to convert a nominal cost of capital to a real cost. Therefore, you should inflate cash flows and then discount at the nominal cost of capital.

**d. Construct annual incremental operating cash flow statements.**

**Answer:**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Year 1 | Year 2 | Year 3 | Year 4 |
| Sales | $250,000 | $257,500 | $265,225 | $273,188 |
| Costs | 125,000 | 128,750 | 132,613 | 136,588 |
| Depreciation | 79,992 | 106,680 | 35,544 | 17,784 |
| Op. EBIT | $45,008 | $22,070 | $97,069 | $118,807 |
| Taxes (40%) | 18,003 | 8,828 | 38,827 | 47,523 |
| EBIT(1 – T) | $27,005 | $13,242 | $58,241 | $71,284 |
| Depreciation | 79,992 | 106,680 | 35,544 | 17,784 |
| Net Operating CF | $106,997 | $119,922 | $93,785 | $89,068 |

**e. Estimate the required net working capital for each year, and the cash flow due to investments in net working capital.**

**Answer:** The project requires a level of net working capital in the amount equal to 12% of the next year’s sales. Any increase in NWC is a negative cash flow, and any decrease is a positive cash flow. This project has a 4-year operating life, so any NWC expenditures will be recovered in Year 4. (That is, accounts receivables are received and inventories are drawn down.)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Year 0 | Year 1 | Year 2 | Year 3 | Year 4 |
| Sales |  | $250,000 | $257,500 | $265,225 | $273,188 |
| NWC (12% of sales) | $30,000 | $30,900 | $31,827 | $32,783 | $0 |
| CF due to NWC | ($30,000) | ($900) | ($927) | ($956) | $32,783 |

**f. Calculate the after-tax salvage cash flow.**

**Answer:** When the project is terminated at the end of Year 4, the equipment can be sold for $25,000. But, since it has been depreciated to a $0 book value, taxes must be paid on the full salvage value. For this project, the after-tax salvage cash flow is:

Salvage Value $25,000

Tax on Salvage Value (10,000)

Net After-Tax Salvage Cash Flow $15,000

**g. Calculate the net cash flows for each year. Based on these cash flows, what are the project’s NPV, IRR, MIRR, PI, payback, and discounted payback? Do these indicators suggest the project should be undertaken?**

**Answer:** The net cash flows are:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Year 0 | Year 1 | Year 2 | Year 3 | Year 4 |
| Initial Outlay | ($240,000) |  |  |  |  |
| Operating Cash Flows |  | $106,997 | $119,922 | $93,785 | $89,068 |
| CF due to NWC | (30,000) | (900) | (927) | (956) | 32,783 |
| Salvage Cash Flows |  |  |  |  | 15,000 |
| Net Cash Flows | ($270,000) | $106,097 | $118,995 | $92,830 | $136,850 |

|  |  |
| --- | --- |
| NPV = | $88,010 |
| IRR = | 23.9% |
| MIRR = | 18.0% |
| Payback = | 2.5 |

**h. What does the term “risk” mean in the context of capital budgeting; to what extent can risk be quantified; and when risk is quantified, is the quantification based primarily on statistical analysis of historical data or on subjective, judgmental estimates?**

**Answer:** Risk throughout finance relates to uncertainty about future events, and in capital budgeting, this means the future profitability of a project. For certain types of projects, it is possible to look back at historical data and to statistically analyze the riskiness of the investment. This is often true when the investment involves an expansion decision; for example, if Sears were opening a new store, if Citibank were opening a new branch, or if GM were expanding its Chevrolet plant, then past experience could be a useful guide to future risk. Similarly, a company that is considering going into a new business might be able to look at historical data on existing firms in that industry to get an idea about the riskiness of its proposed investment. However, there are times when it is impossible to obtain historical data regarding proposed investments; for example, if GM were considering the development of an electric auto, not much relevant historical data for assessing the riskiness of the project would be available. Rather, GM would have to rely primarily on the judgment of its executives, and they, in turn would have to rely on their experience in developing, manufacturing, and marketing new products. We will try to quantify risk analysis, but you must recognize at the outset that some of the data used in the analysis will necessarily be based on subjective judgments rather than on hard statistical observations.

**i. 1. What are the three types of risk that are relevant in capital budgeting?**

**2. How is each of these risk types measured, and how do they relate to one another?**

**Answer:** Here are the three types of project risk:

* 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 of NPV (σNPV) or its coefficient of variation of NPV (CVNPV). Note that other profitability measures, such as IRR and MIRR, can also be used to obtain stand-alone risk estimates.
* Within-firm 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 (b) 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 project’s corporate beta, which is the slope of the regression line formed by plotting returns on the project versus returns on the firm.
* Market risk is the riskiness of the project to a well-diversified investor, hence it considers the diversification inherent in stockholders’ portfolios. It is measured by the project’s market beta, which is the slope of the regression line formed by plotting returns on the project versus returns on the market.

**i. 3. How is each type of risk used in the capital budgeting process?**

**Answer:** 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.

Unfortunately, by far the easiest type of risk to measure is a project’s stand-alone risk. Thus, firms often focus on this type of risk when making capital budgeting decisions. However, this focus does not necessarily lead to poor decisions, because most projects that a firm undertakes are in its core business. In this situation, a project’s stand-alone risk is likely to be highly correlated with its within-firm risk, which in turn is likely to be highly correlated with its market risk.

**j. 1. What is sensitivity analysis?**

**Answer:** Sensitivity analysis 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.)

**j. 2. Perform a sensitivity analysis on the unit sales, salvage value, and cost of capital for the project. Assume each of these variables can vary from its base-case, or expected, value by ±10%, ±20%, and ±30%. Include a sensitivity diagram, and discuss the results.**

**Answer:** The sensitivity data are given here in tabular form:

|  |  |  |  |
| --- | --- | --- | --- |
| Deviation  from  Base Case |  | NPV Deviation from Base Case | |
| WACC | Units  Sold | Salvage |
| -30% | $113,270 | $16,649 | $84,936 |
| -15% | 100,291 | 52,329 | 86,473 |
| 0% | 88,010 | 88,010 | 88,010 |
| 15% | 76,378 | 123,690 | 89,546 |
| 30% | 65,350 | 159,371 | 91,083 |
|  |  |  |  |
| Range | $47,920 | $176,020 | $6,147 |

We generated these data with a spreadsheet model in the file *Ch11 Mini Case Model.xls.*



A. The sensitivity lines intersect at 0% change and the base-case NPV, $88,030. Since all other variables are set at their base-case, or expected, values the zero change situation is the base case and gives the base-case NPV, $88,030.

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

C. 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.

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

**j. 3. What is the primary weakness of sensitivity analysis? What is its primary usefulness?**

**Answer:** 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. It also ignores any relationships between variables, such as unit sales and sales price.

Therefore, in many situations, sensitivity analysis is not a particularly good risk indicator. 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.

**k. Assume that Sidney Johnson is confident of her estimates of all the variables that affect the project’s cash flows except unit sales and sales price. If product acceptance is poor, unit sales would be only 900 units a year and the unit price would only be $160; a strong consumer response would produce sales of 1,600 units and a unit price of $240. Sidney believes 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).**

**k. 1. What is scenario analysis?**

**Answer:** Scenario analysis examines several possible situations, usually worst case, most likely case, and best case. It provides a range of possible outcomes.

**k. 2. What is the worst-case NPV? The best-case NPV?**

**k. 3. Use the worst-, base-, and best-case NPVs and probabilities of occurrence to find the project’s expected NPV, standard deviation, and coefficient of variation.**

**Answer:** We used a spreadsheet model to develop the scenarios, which are summarized below:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Scenario | Probability | Unit Sales | Unit Price | NPV |
| Best Case | 25% | 1,600 | $240 | $278,940 |
| Base Case | 50% | 1,250 | $200 | $88,010 |
| Worst Case | 25% | 900 | $160 | ($48,527) |
|  |  | Expected NPV = | | $101,608 |
|  |  | Standard Deviation = | | $116,573 |
| Coefficient of Variation = | | | |  |
| Std. Dev./Expected NPV = | | | | 1.15 |

**l. Are there problems with scenario analysis? Define simulation analysis, and discuss its principal advantages and disadvantages.**

**Answer:** Scenario analysis examines several possible scenarios, usually worst case, most likely case, and best case. Thus, it usually considers only 3 possible outcomes. Obviously the world is much more complex, and most projects have an almost infinite number of possible outcomes.

Simulation analysis is a type of scenario analysis that uses randomly generated inputs rather than specific values. Here the uncertain cash flow variables (such as unit sales) are entered as continuous probability distribution parameters rather than as point values. Then, the computer uses a random number generator to select values for the uncertain variables on the basis of their designated distributions. Once all of the variable values have been selected, they are combined and an NPV is calculated. The process is repeated many times, say 1,000 times, with new values selected from the distributions for each run. The end result is a probability distribution of NPV based on a sample of 1,000 values. Simulation can provide the distribution as well as summary statistics such as expected NPV and σNPV. Simulation provides the decision maker with a better idea of the profitability of a project than does scenario analysis because it incorporates many more possible outcomes.

Although simulation analysis is technically refined, its usefulness is limited because managers are often unable to accurately specify the variables’ probability distributions. Further, the correlations among the uncertain variables must be specified, along with the correlations over time. If managers are unable to do this with much confidence, then the results of simulation analyses are of limited value.

Recognize also that neither sensitivity, scenario, nor simulation analysis provides a decision rule—they may indicate that a project is relatively risky, but they do not indicate whether the project’s expected return is sufficient to compensate for its risk.

Finally, remember that sensitivity, scenario, and simulation analyses all focus on stand-alone risk, which is not the most relevant risk in capital budgeting analysis.

**m. 1. Assume that Shrieves’ average project has a coefficient of variation in the range of 0.2 to 0.4. Would the new line be classified as high risk, average risk, or low risk? What type of risk is being measured here?**

**Answer:** The project has a CV of 1.15, which is above the average range of 0.2 to 0.4, 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 NPV) about the expected return.

**m. 2. Shrieves typically adds or subtracts 3 percentage points to the overall cost of capital to adjust for risk. Should the new line be accepted?**

**Answer:** 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 $65,371, so it would still be acceptable. If it were a low-risk project, its cost of capital would be 7%, its NPV would be $113,288, and it would be an even more profitable project on a risk-adjusted basis.

**m. 3. Are there any subjective risk factors that should be considered before the final decision is made?**

**Answer:** 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, as a result of “abandonment possibilities,” the project may be less risky than the analysis indicates.

**n. What is a real option? What are some types of real options?**

**Answer:** Real options exist when managers can influence the size and risk of a project’s cash flows by taking different actions during the project’s life in response to changing market conditions. Some types of real options are listed below:

1. Investment timing options

2. Growth options

a. Expansion of existing product line

b. New products

c. New geographic markets

3. Abandonment options

a. Contraction

b. Temporary suspension

c. Complete abandonment

4. Flexibility options

a. Inputs

b. Outputs

c. Both