CHAPTER 12

CASH FLOW ESTIMATION AND RISK ANALYSIS

Home Depot Keeps Growing

Home Depot Inc. (HD) has grown phenomenally since 1990, and it shows no signs of slowing down. At the beginning of 1990, it had 118 stores with annual sales of $2.8 billion. By early 2005, it had 1,866 stores and annual sales of $65 billion. Stockholders have benefited mightily from this growth, as the stock's price has increased from a split-adjusted $1.87 in 1990 to $32.35 in early 2005, or by 1,630 percent.

Home Depot

Despite concerns that the economy might be slowing, the company expects to open another 175 stores in 2005. It costs, on average, over $20 million to purchase land, construct a new store, and stock it with inventory. (The required inventory investment is $7 million, but suppliers provide $4 million in the form of accounts payable.) Each new store involves a capital expenditure of about $17 million, so the company must perform a financial analysis to determine if a potential store's expected cash flows will cover its costs.

Home Depot uses information from its existing stores to forecast new stores' expected cash flows. Thus far, its forecasts have been outstanding, but there are always risks. First, a store's sales might be less than projected if the economy weakens. Second, some of HD's customers might in the future bypass it altogether and buy directly from manufacturers through the Internet. Third, its new stores could "cannibalize," that is, take sales away from, its existing stores. This happens when large, multi-store retailers oversaturate a given market area. The companies first pick the "low-hanging fruit," that is, enter the most attractive markets.

To avoid cannibalization by opening new stores too close to older ones while still generating substantial growth, HD has been developing complementary formats. For example, it rolled out its Expo Design Center chain, which offers one-stop sales and service for kitchen and bath and other remodeling and renovation work.

Rational expansion decisions require detailed assessments of the forecasted cash flows, along with a measure of the risk that forecasted sales might not be realized. That information can then be used to determine the risk-adjusted NPV associated with each potential project. In this chapter, we describe techniques for estimating projects' cash flows and the associated risk. Companies such as Home Depot use these techniques on a regular basis when making capital budgeting decisions.

Putting Things In Perspective

The basic principles of capital budgeting were covered in Chapter 11. Given a project's expected cash flows, it is easy to calculate the primary decision criterion, the NPV, as well as the supplemental criteria, IRR, MIRR, payback, and discounted payback. However, in the real world cash flows are not just provided as they were in the last chapter—rather, they must be estimated based on information from various sources. Moreover, uncertainty surrounds the cash flow estimates, and some projects are less certain and thus riskier than others. In this chapter, we go through an example that illustrates how project cash flows are estimated and discuss techniques for measuring and then dealing with risk.

Also, recall that in Chapter 9 we discussed how a firm's value is fundamentally dependent on its free cash flows. We will see in this chapter that there is a direct relationship between capital budgeting, the firm's free cash flows, and therefore the value of its stock. Indeed, since capital budgeting is the primary source of cash flows, one could argue that it is the primary determinant of stock prices.

12.1 BACKGROUND ON THE PROJECT

In Chapter 11 we saw that the NPV method, generally supplemented by the IRR and several other criteria, is used when deciding whether or not to accept potential projects. Conceptually, the decision is straightforward: A potential project creates value for the firm's shareholders, if and only if, its NPV is positive, so firms should accept positive NPV projects and reject those with negative NPVs. This is easy enough in theory, but in practice estimating the cash flows can be difficult, and it requires care and judgment. However, if we adhere to the principles discussed in this chapter, reasonable cash flow estimates and thus reliable NPVs can be obtained.

We illustrate the capital budgeting process with a new project being considered by Brandt-Quigley Corporation (BQC), an Atlanta-based technology company. BQC's research and development department has used its expertise in microprocessor technology to develop a small computer designed to control home appliances. The computer automatically controls the heating and air-conditioning system as well as the security system, hot water heater, oven, and even small appliances such as a coffee maker. By increasing a home's energy efficiency, the computer can cut the average homeowner's costs enough to pay for itself within three years. Developments have now reached the stage where a decision must be made about whether to go forward with full-scale production. BQC currently has a profitable division that produces mechanical (as opposed to computerized) controls that do some of the things the new system would do. However, the new system would be far superior to the existing product and thus would enable BQC to increase its share of the home controls market.

Also, the idea for the new computer actually came as a by-product from work the company was doing on other projects. The R&D manager saw its potential and authorized the expenditure of $500,000 to look into the feasibility of the new controls computer. This cost was incurred in 2005, charged to general corporate R&D, and expensed in 2005 for tax purposes.

BQC's marketing vice president believes that 20,000 units could be sold per year if they were priced at $3,000 each, so annual sales revenues are estimated at $60 million. The firm would need additional manufacturing capability, and BQC has an option to purchase an existing building at a cost of $12 million to meet this need. The building would be paid for on December 31, 2006, and for tax purposes it would be depreciated under MACRS with a 39-year life. BQC has an unused building that could be used for the new project, but the project manager decided that the building under option would work out better.

The necessary equipment would be purchased and installed late in 2006 and paid for on December 31, 2006. The equipment would fall into the MACRS 5-year class, and it would cost $8 million, including transportation and installation.

The project would also require an investment of $6 million in net working capital, which would also be made on December 31, 2006.[1] This investment would be recovered at the end of the project's life.

Operations would commence in January 2007, and the project's estimated economic life would be 4 years, from 2007 through 2010. At the end of 2010, the building should have a market value of $7.5 million versus a book value of $10.91 million, while the equipment should have a market value of $2 million versus a book value of $1.36 million.

Variable manufacturing costs are estimated at $2,100 per unit, and fixed overhead costs, excluding depreciation, would be $8 million a year. Depreciation expenses as shown in Table 12-1, Part 2, were determined as shown in Appendix 12A, which explains Internal Revenue Service allowed procedures.

BQC's marginal federal-plus-state tax rate is 40 percent; its corporate WACC is 12 percent; and, for capital budgeting purposes, the company assumes that operating cash flows occur at the end of each year. Because the plant would begin operations on January 1, 2007, the first operating cash flows would occur on December 31, 2007.

Several other points should be noted: (1) BQC is a relatively large corporation, with sales of more than $4 billion, and it takes on many investments each year. Thus, if the computer control project does not work out, it will not bankrupt the company—this is not a "bet-the-company project." (2) If the project is accepted, the company will be contractually obligated (to component suppliers) to operate it for the full four-year life. However, the company might be able to negotiate a release from this restriction. (3) The project's returns would be positively correlated with returns on other BQC projects and also with the stock

[1] Inventories and receivables would increase by $8 million while payables and accruals would increase by $2 million, so net operating working capital would increase by $6 million. This amount would have to be financed by investors, and it would be part of the project's capital requirements.

market—this project would do well if other parts of the firm were doing well, which would happen if the general economy were strong.

Assume that you are on the company's financial staff, and you must conduct the capital budgeting analysis. For now, assume that the project is about as risky as an average BQC project, so use the corporate WACC, 12 percent.

12.2 PROJECT ANALYSIS

Capital budgeting projects can be analyzed using a calculator or with a spreadsheet such as *Excel*. Either way, one must conduct the analysis as shown in Parts 1 through 5 of Table 12-1. For exam purposes, you will probably have to work with a calculator. However, for reasons that will become obvious as we go through the analysis, spreadsheets are much more efficient and are virtually always used in practice. Even so, the setup and the analysis are exactly the same for both the calculator and computer approaches.

Table 12-1 is a printout from the chapter model, divided into five parts:

1. Input Data.
2. Depreciation Schedule.
3. Salvage Value Calculations.
4. Projected Cash Flows.
5. Appraisal of the Proposed Project.[2]

The table shows row and column headers, and cells in the table can be identified by cell references such as "D17," which is the cell for the building cost, found in "Part 1. Input Data." If we deleted the row and column headers, the table would look like the setup for a calculator analysis, and a calculator would indeed give you exactly the same answers.

Input Data, Part 1

The Input Data section provides the basic data used in the analysis. The inputs are really *assumptions*—thus, in the analysis we *assume* that 20,000 units can be sold at a price of $3,000 per unit.[3] Some of the inputs are known with near certainty—for example, the 40 percent tax rate is not likely to change. Others are more speculative—units sold and the variable costs are in this category. Obviously, if sales or costs are different from the assumed levels, then profits and cash flows, hence NPV and the other outputs, will differ from their calculated levels. Later in the chapter we demonstrate how changes in the inputs can affect the results.

Depreciation Schedule, Part 2

Here we calculate depreciation over the project's four-year life. Rows 28 through 31 give data on the building. Row 28 shows the MACRS rates. Row 29 shows the dollar depreciation charge, which is the rate times the asset's depreciable basis, which in this example is the initial cost. Row 30 shows the cumulative depreciation taken through the year, and Row 31 shows the book value at the end of each year, found by subtracting the accumulated depreciation from the original depreciable basis. This same information is provided for the equipment on Rows 32 through 35.

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[2] If you have access to a computer, you might want to look at the model, *12 Chapter Model.xls*.

[3] The sales price is $3,000, but for convenience we show dollars in thousands in the model and thus in the table.

TABLE 12-1 *Parts 1 and 2: Input Data and Depreciation (Thousands of Dollars)*

	A	B	C	D	E	F	G	H	I
15	**Part 1. Input Data**								
16									
17	Building cost (= Depr'n basis)			$12,000					
18	Equipment cost (= Depr'n basis)			$8,000		Market value of building in 2010			$7,500
19	Net Operating WC			$6,000		Market value of equip. in 2010			$2,000
20	First year sales (in units)			20,000		Tax rate			40%
21	Growth rate in units sold			0.0%		WACC			12%
22	Sales price per unit			$3.00		Inflation: growth in sales price			0.0%
23	Variable cost per unit			$2.10		Inflation: growth in VC per unit			0.0%
24	Fixed costs			$8,000		Inflation: growth in fixed costs			0.0%
25									
26	**Part 2. Depreciation Schedule**[a]				Years				
27					2007	2008	2009	2010	
28	Building Depr'n Rate				1.3%	2.6%	2.6%	2.6%	
29	Building Depr'n Expense				$156	$312	$312	$312	
30	Cumulative Depr'n				$156	$468	$780	$1,092	
31	Ending Book Value: Cost − Cum. Depr'n				$11,844	$11,532	$11,220	$10,908	
32	Equipment Depr'n Rate				20.0%	32.0%	19.0%	12.0%	
33	Equipment Depr'n Expense				$1,600	$2,560	$1,520	$960	
34	Cumulative Depr'n				$1,600	$4,160	$5,680	$6,640	
35	Ending Book Value: Cost − Cum. Depr'n				$6,400	$3,840	$2,320	$1,360	
36	[a] The indicated percentages are multiplied by the depreciable basis ($12,000 for the building and $8,000 for								
37	the equipment) to determine the depreciation expense for the year.								

Salvage Value Calculations, Part 3

Here we show the estimated cash flows the firm will realize when it disposes of the building and equipment. Row 42 shows the expected market (salvage) value when it sells each asset 4 years hence. Row 43 shows the book values at the end of Year 4 as calculated in Part 2. Row 44 shows the expected gain or loss, defined as the difference between the market and book values.

Gains and losses are treated as ordinary income, not capital gains or losses.[4] Gains result in tax liabilities while losses produce tax credits. These are equal to the gain or loss times the 40 percent tax rate, and they are shown on Row 45. Finally, Row 46 shows the after-tax cash flow the company expects to receive when it disposes of the asset, found as the salvage value minus the tax liability or plus the credit. Thus, BQC expects to net $8.863 million from the sale of the building and $1.744 million from the equipment, for a total of $10.607 million.

[4] If an asset is sold for exactly its book value, there will be no gain or loss, hence no tax liability or credit. However, if an asset is sold for other than its book value, a gain or loss will be created. For example, BQC's building will have a book value of $10,908, but the company expects to realize only $7,500 when it is sold. This would result in a loss of $3,408. This indicates that the building should have been depreciated at a faster rate—only if accumulated depreciation had been $3,408 larger would the book and salvage values have been equal. So, the Tax Code stipulates that losses on the sale of operating assets can be used to reduce ordinary income, just as depreciation reduces income. On the other hand, if an asset is sold for *more* than its book value, as is the case for the equipment, then this signifies that the depreciation rates were too high, so the gain is called "depreciation recapture" and is taxed as ordinary income.

TABLE 12-1 *Part 3: Salvage Value Calculations (Thousands of Dollars)*

	A	E	F	G
40	**Part 3. Salvage Value Calculations**			
41		Building	Equipment	Total
42	Estimated Market Value in 2010	$7,500	$2,000	
43	Book Value in 2010[b]	10,908	1,360	
44	Expected Gain or Loss[c]	−3,408	640	
45	Tax liability or credit	−1,363	256	
46	Net cash flow from salvage[d]	$8,863	$1,744	$10,607
47				
48	[b] Book value equals depreciable basis (initial cost in this case) minus accumulated MACRS depreciation.			
49	For the building, accumulated depreciation is $1,092, so book value is $12,000 − $1,092 = $10,908. For the			
50	equipment, accumulated depreciation is $6,640, so book value is $8,000 − $6,640 = $1,360.			
51				
52	[c] Building: $7,500 market value − $10,908 book value = −$3,408, a loss. Thus there's a shortfall in depreciation			
53	taken versus "true" depreciation, and it is treated as an operating expense for 2010. Equipment: $2,000			
54	market value − $1,360 book value = $640 profit. Here the depreciation charge exceeds the "true"			
55	depreciation, and the difference is called "depreciation recapture." It is taxed as ordinary income in 2010.			
56				
57	[d] Net cash flow from salvage equals salvage (market) value minus taxes. For the building, the loss results			
58	in a tax credit, so net salvage value = $7,500 − (−$1,363) = $8,863.			

Projected Cash Flows, Part 4

We use the information developed in Parts 1, 2, and 3 to find the project's forecasted stream of cash flows. Five periods are shown, from Year 0 (2006) to Year 4 (2010). The cash outlays required at Year 0 are the negative numbers in Column E, and their sum, −$26 million, is shown on Row 88. We calculate the operating cash flows in the next four columns. We begin with units sold (20,000 per year), then show the sales price, and then the sales revenues, found as the product of units sold times the sales price.[5] Next, we subtract variable costs, found by multiplying the 20,000 units times the $2,100 cost per unit. Fixed operating costs and depreciation on the building and equipment are then deducted to find operating earnings before interest and taxes, or EBIT. No interest is deducted because it is accounted for by discounting the cash flows.[6] Taxes (at a 40 percent rate) must be subtracted, leaving us with net operating profit after taxes, or NOPAT.

Note that we are seeking *cash flows*, not accounting income. BQC requires payment upon delivery, and both taxes and all expenses other than depreciation must be paid in cash. Therefore, each item in the "Operating Cash Flows" section of Part 4 represents cash with one exception—*depreciation*, which is a noncash charge. Because depreciation is not a cash charge, it is added back (on Row 80) to obtain the operating cash flow, which is shown on Row 81.

When the project's life ends at the end of Year 4, the company will receive the "Terminal Year Cash Flows" as shown on Rows 84, 85, and 86. As shown on Row 66, BQC must invest $6 million in working capital—inventories and

[5] Notice in Part 1, Input Data, that we show a growth rate in unit sales and inflation rates for the sales price, variable costs, and fixed costs. BQC anticipates that unit sales, the sales price, and costs will be stable for the project's life, so these variables are all set at zero. However, nonzero values could be inserted in the input section to determine the effects of growth and inflation. The inflation figures are all specific for this particular project—they do not reflect inflation as measured by the CPI. The expected CPI inflation rate as seen by marginal investors is built into the WACC, and neither it nor WACC is expected to change over the forecast period.

[6] If we deducted interest when finding the cash flows, then discounted those cash flows, this would double count interest.

TABLE 12-1 *Part 4: Projected Cash Flows (Thousands of Dollars)*

	A–D	E	F	G	H	I
60	**Part 4. Projected Cash Flows**			Years		
61		0	1	2	3	4
62		2006	2007	2008	2009	2010
63	*Investment Outlays at Time Zero*					
64	Building	−$12,000				
65	Equipment	−8,000				
66	Increase in Net Working Capital	−6,000				
67						
68	*Operating Cash Flows over the Project's Life*					
69	Units sold		20,000	20,000	20,000	20,000
70	Sales price		$3.00	$3.00	$3.00	$3.00
71						
72	Sales revenue		$60,000	$60,000	$60,000	$60,000
73	Variable costs		42,000	42,000	42,000	42,000
74	Fixed operating costs		8,000	8,000	8,000	8,000
75	Depreciation (building)		156	312	312	312
76	Depreciation (equipment)		1,600	2,560	1,520	960
77	EBIT		$8,244	$7,128	$8,168	$8,728
78	Taxes on operating income (40%)		3,298	2,851	3,267	3,491
79	NOPAT		$4,946	$4,277	$4,901	$5,237
80	Add back depreciation		1,756	2,872	1,832	1,272
81	Operating cash flow		$6,702	$7,149	$6,733	$6,509
82						
83	*Terminal Year Cash Flows*					
84	Return of net operating working capital[e]					$6,000
85	Net salvage value					10,607
86	Total termination cash flows					$16,607
87						
88	Projected Cash Flows (CF time line)	−$26,000	$6,702	$7,149	$6,733	$23,116
89						
90	[e] Net working capital will be recovered at the end of the project's operating life, at year-end 2010, as					
91	inventories are sold off and receivables are collected.					

accounts receivable less payables and accruals—at Year 0. However, as operations wind down in Year 4, inventories would be sold and not replaced, and accounts receivable would be collected and not replaced, and both of these actions would provide cash. The end result is that the firm would recover its $6 million investment in working capital during the project's last year. In addition, when the company disposes of the building and equipment at the end of Year 4, it would receive the $10.607 million net salvage value as estimated in Part 3 of the table. Thus, total terminal year cash flows total $16.607 million as shown on Row 86. When we sum the columns in Part 4, we obtain the projected cash flows on Row 88. Those cash flows constitute a *cash flow time line*, just like the cash flow time lines we analyzed in Chapter 11, and they are evaluated in Part 5.

Appraisal of the Proposed Project, Part 5

In Part 5 of the table we calculate the key decision criteria—NPV, IRR, MIRR, and payback—based on the cash flows on Row 88. BQC focuses primarily on the NPV, and since it is positive, the project appears to be acceptable. The other outputs all support this conclusion—the IRR and MIRR both exceed the 12 percent WACC, and the payback indicates that the project would return the invested funds in 3.23 years. Therefore, on the basis of the analysis thus far, it appears that the project should be accepted. However, we have assumed thus far that the

TABLE 12-1 *Part 5: Appraisal of the Proposed Project*

	A	B	C	D	E	F	G	H	I
93	**Part 5. Appraisal of the Proposed Project**								
94									
95	NPV (at 12%)			$5,166					
96	IRR			19.33%					
97	MIRR			17.19%					
98	Payback (Excel function)			3.23					

project is about as risky as an average project. If the project is later judged to be riskier than average, it would be necessary to increase the WACC, which in turn might cause the NPV to become negative and the IRR and MIRR to drop below the then-higher WACC. Therefore, we cannot make a final go/no-go decision until we evaluate the project's risk, the topic of Section 12.4.

SELF TEST

Refer to Table 12-1 and answer these questions:

(1) If the WACC increased to 15 percent, what would the new NPV be? ($2,877)

(2) Look at Part 1, Input Data. In what direction would NPV be changed by an *increase* in each input variable?

(3) If the equipment had to be depreciated over a 10-year life rather than a 5-year life, but other aspects of the project were unchanged, would the NPV increase or decrease? Why?

(4) It is relatively easy to determine the effect of an increase in the WACC. Would it be equally easy to quantify the effects of changes in the other variables if (a) you were working with a calculator or (b) you were working with an *Excel* spreadsheet? Why?

12.3 OTHER POINTS ON CASH FLOW ANALYSIS

We can use the BQC case to illustrate several other important points related to determining the cash flows that are relevant in a capital budgeting analysis.

Cash Flow versus Accounting Income

We calculated the BQC project's expected cash flows, not its net income. Net income would be based on the depreciation rate the firm's accountants chose to use, not necessarily the depreciation rates allowed by the IRS. Also, net income would represent the income that belongs to the stockholders, not that available to all investors, so interest charges would be deducted. Moreover, the investment in working capital would not be deducted, nor would its later recovery be taken into account. For these and other reasons, net income is generally different from cash flow. Each has a role in financial management, *but for capital budgeting purposes it is the project's cash flow, not its net accounting income, that is relevant*.

Timing of Cash Flows

Accounting income statements are for periods such as years or months, so they do not reflect the exact timing of when cash revenues and expenses occur. Because of the time value of money, capital budgeting analyses should in theory deal with cash flows exactly as they occur. 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.

Incremental Cash Flows

A project's **incremental cash flow** is defined as one that will occur *if and only if* the firm takes on the project. All of the cash flows in Table 12-1 are obviously incremental—BQC would not make the investments in buildings, equipment, and working capital if the project were not accepted, nor would it receive the operating cash flows shown in the table. However, some items are not so obvious, as we discuss next.

Incremental Cash Flow
A cash flow that will occur if and only if the firm takes on a project.

Replacement Projects

The BQC analysis related to a completely new project, where a new product will be produced. The analysis is somewhat different if a **replacement analysis** is involved, where the project calls for replacing machinery used to produce an existing product. Here 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. Thus, a more efficient new machine might require labor of $100,000 per year versus $175,000 with the old machine. The difference, a savings of $75,000, would be built into the analysis. Similarly, we would need to find the difference in depreciation and any other factor that affects cash flows. We do not discuss replacement decisions further in the text, but we do explain and illustrate the process on a tab in the chapter model and in Web Appendix 12B.

Replacement Analysis
The situation where old and less efficient equipment is replaced by newer and more efficient equipment.

Sunk Costs

A **sunk cost** is an outlay that was incurred in the past and cannot be recovered regardless of whether or not the project under consideration is accepted. In capital budgeting, we are concerned with *future incremental cash flows*—we want to know if the new investment will justify enough incremental cash flow to justify the incremental investment. Because sunk costs were incurred in the past and will not be changed regardless of whether or not the project under consideration is accepted or rejected, they are not relevant in the capital budgeting analysis. The $500,000 BQC spent in 2005 on R&D related to the computer project is a sunk cost. That cash flow was incurred in the past—the money is gone, and it won't come back regardless of whether or not BQC decides to accept the new project.

Sunk Cost
A cash outlay that has already been incurred and that cannot be recovered regardless of whether the project is accepted or rejected.

The project's expected NPV as calculated in Table 12-1, Part 5, was $5,166,000. The R&D expenditure was $500,000. Therefore, even if this expenditure were incorrectly charged to the project, the NPV would still be positive, so the mistake would not change the decision. But suppose the R&D had been $6,000,000. If that amount were taken as a cost of the project, then the NPV would be negative and the project would be rejected. *However, that would be a bad decision*: The real issue is whether or not the *incremental* cash inflows as shown in Table 12-1 exceed the *incremental* cash outflow by enough to cause the NPV to be positive, and the analysis in the table indicates that they do. So, including sunk costs could lead to an incorrect decision.

Opportunity Costs

Opportunity Costs
The return on the best alternative use of an asset, or the highest return that will not be earned if funds are invested in a particular project.

Another issue relates to **opportunity costs,** which are cash flows that could be generated from an asset the firm already owns, provided the asset is not used for the project in question. Recall from the background section that BQC owns a building that could be used for the computer project. Management decided to buy a new building rather than use the one it owns, but for illustrative purposes suppose it had decided to use the existing building. The company already owns the building, so it would not incur the $12 million cash outlay to buy a new building. Would this mean that we should delete the $12 million expenditure from the analysis, which would obviously raise the estimated NPV above the $5.166 million we found in Table 12-1?

The answer is that we should remove the cash flows related to the new building, but we should include the *opportunity cost* associated with the existing building as a cash cost. For example, if the building had a market value, after taxes and brokerage expenses, of $13 million, then BQC would be giving up $13 million if it used the building for the computer project. Therefore, we should charge the $13 million that would be foregone to the project as an opportunity cost.

Externalities

Externality
An effect on the firm or the environment that is not reflected in the project's cash flows.

Cannibalization Effect
The situation when a new project reduces cash flows that the firm would otherwise have had.

Another potential problem involves **externalities,** which are the effects a project has on other parts of the firm or on the environment. As was noted in the background section, BQC currently makes mechanical controls that are profitable, and the new computerized controls would take away some of that business. Thus, while the new project would generate positive cash flows, it would also reduce some of the company's current cash flows. This type of externality is called a **cannibalization effect,** because the new business would eat into the company's existing business. The lost cash flows should be charged to the new project. However, it often turns out that if the one company does not produce a new product, some other company will, so the old cash flows would be lost anyway. In this case, no charge should be assessed against the new project. All this makes determining the cannibalization effect difficult, because it requires estimates of changes in sales and costs, and also the timing of when those changes would occur. Still, cannibalization can be important, so its potential effects should be considered.

Note that externalities can be positive as well as negative. For example, suppose BQC also produces high-priced convection ovens, and the new control units would make the ovens more efficient and easier to use. In that case, the control project might lead to higher oven sales, in which case some of the incremental cash flows in the stove division should be attributed to the control project. It often turns out that a project's direct cash flows are insufficient to produce a positive NPV, but when indirect effects are considered, the project is deemed to be a good one.

Firms must also be concerned with *environmental externalities*. For example, it might be that manufacturing the new computers would give off noxious fumes that, while not bad enough to trigger governmental actions, would still cause ill feelings in the plant's neighborhood. Those ill feelings might not show up in the cash flow analysis, but they should still be considered. Perhaps a relatively small expenditure could correct the problem and keep the firm from suffering future ill will which might be costly in some hard-to-measure way.

SELF TEST

Why should companies use project cash flow rather than accounting income when finding the NPV of a project?

Explain the following terms: incremental cash flow, sunk cost, opportunity cost, externality, and cannibalization.

Give an example of a "good" externality, that is, one that makes a project look better.

12.4 ESTIMATING PROJECT RISK

Although it is clear that riskier projects should be assigned a higher cost of capital, it is often difficult to estimate project risk. First, note that three separate and distinct types of risk can be identified:

1. **Stand-alone risk,** which is the project's risk disregarding the facts (a) that it is but one asset within the firm's portfolio of assets and (b) 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.
2. **Corporate, or within-firm, risk,** which is the project's risk to the corporation, giving consideration to the fact that the project represents only one of the firm's portfolio of assets, hence that 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.
3. **Market, or beta, risk,** which 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.

Stand-Alone Risk
The risk an asset would have if it were a firm's only asset and if investors owned only one stock. It is measured by the variability of the asset's expected returns.

Corporate, or Within-Firm, Risk
Risk not considering the effects of stockholders' diversification; it is measured by a project's effect on uncertainty about the firm's future earnings.

Market, or Beta, Risk
That part of a project's risk that cannot be eliminated by diversification; it is measured by the project's beta coefficient.

Taking on a project with a high degree of either stand-alone or corporate risk will not necessarily affect the firm's beta. However, if the project has highly uncertain returns, and if those returns are highly correlated with returns on the firm's other assets and with most other firms in the economy, the project will have a high degree of all types of risk. For example, suppose General Motors decides to undertake a major expansion to build commuter airplanes. GM is not sure how its technology will work on a mass production basis, so there are great risks in the venture—its stand-alone risk is high. Management also estimates that the project will do best if the economy is strong, for then people will have more money to spend on the new planes. This means that the project will tend to do well if GM's other divisions do well and do badly if other divisions do badly. This being the case, the project will also have a high corporate risk. Finally, since GM's profits are highly correlated with those of most other firms, the project's beta will also be high. Thus, this project will be risky under all three definitions of risk.

Of the three measures, market risk is theoretically the most relevant because it is the one reflected in stock prices. Unfortunately, market risk is also the most difficult to estimate, because projects don't have "market prices" that can be related to stock market returns. For this reason, most decision makers consider all three risk measures in a judgmental manner and then classify projects into subjective risk categories. Then, using the composite WACC as a starting point,

Risk-Adjusted Cost of Capital
The cost of capital appropriate for a given project, given the riskiness of that project. The greater the risk, the higher the cost of capital.

risk-adjusted costs of capital are developed for each category. For example, a firm might establish three risk classes, then assign the corporate WACC to average-risk projects, use a somewhat higher cost rate for higher-risk projects, and a somewhat lower rate for lower-risk projects. Thus, if a company's composite WACC estimate were 10 percent, its managers might use 10 percent to evaluate average-risk projects, 12 percent for high-risk projects, and 8 percent for low-risk projects. While this approach is probably better than not making any risk adjustments, these adjustments are subjective and often arbitrary. Unfortunately, there's no perfect way to specify how much higher or lower we should go in setting risk-adjusted costs of capital.[7]

SELF TEST

What are the three types of project risk?

Which type of project risk is theoretically the most relevant? Why?

Explain the classification scheme many firms use when developing *subjective* risk-adjusted costs of capital.

12.5 MEASURING STAND-ALONE RISK

A project's stand-alone risk is determined by the uncertainty inherent in its cash flows. Most of the key inputs shown in Part 1 of Table 12-1 for BQC's appliance control computer project are subject to uncertainty. Sales were projected at 20,000 units to be sold at a price of $3,000 per unit. However, actual unit sales would almost certainly be somewhat higher or lower than 20,000, and the price would probably turn out to be different from the projected $3,000 per unit. Similarly, the other variables would probably differ from their indicated values. *Indeed, all the inputs are expected values of probability distributions, and as such they could vary from their expected values.*

Three techniques are used to assess risk: (1) sensitivity analysis, (2) scenario analysis, and (3) Monte Carlo simulation. We discuss them in the following sections.

Sensitivity Analysis

Sensitivity Analysis
A risk analysis technique in which key variables are changed one at a time and the resulting changes in the NPV are observed.

Base-Case NPV
The NPV when sales and other input variables are set equal to their most likely (or base-case) values.

Intuitively, we know that the input variables could turn out to be different from the values used in the analysis. We also know that a change in a key input variable such as units sold would cause the NPV to change. **Sensitivity analysis** measures the percentage change in NPV that results from a given percentage change in an input variable, other things held constant.

Sensitivity analysis begins with a *base-case* situation, where the *expected value* is used for each input variable. The input data in Part 1 of Table 12-1 are the *most likely, or base-case, values*, and the resulting $5.166 million NPV shown in Part 5 of the table is the **base-case NPV.**

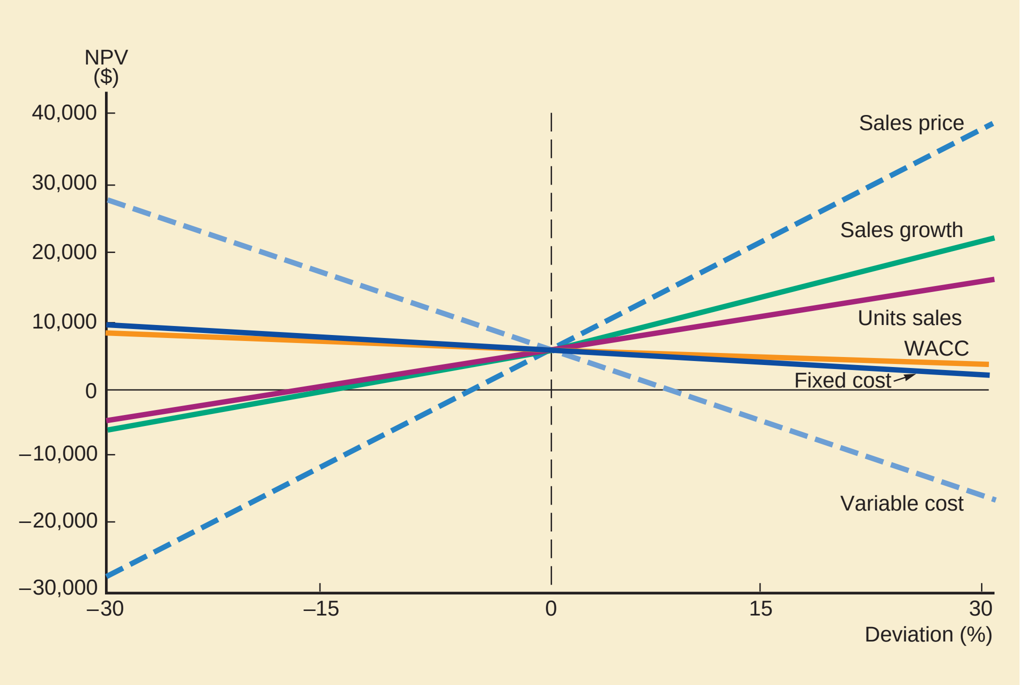
When senior managers review capital budgeting studies, they are interested in the base-case NPV, but they generally go ask a series of "what if" questions: "What if unit sales turn out to be 15 percent below the most likely level?" "What if the sales price per unit is actually $2,500, not $3,000?" "What if variable costs are $2,500 per unit rather than the expected $2,100?" Sensitivity analysis is designed

[7] We should note that the CAPM approach can be used for projects provided there are specialized publicly-traded firms in the same business as that of the project under consideration. For further information on estimating the risk-adjusted cost of capital see Web Appendix 12D, and for more information on measuring market (or beta) risk see Web Appendix 12E.

to provide answers to such questions. Each variable is increased or decreased by several percentage points from its expected value, holding all other variables constant. Then NPVs are calculated using each of these values. Finally, the resulting set of NPVs is plotted to show how sensitive NPV is to changes in each variable.

Figure 12-1 shows the computer project's sensitivity graph for the six most important input variables.[8] The table below the graph gives the NPVs based on different values of the inputs, and those NPVs were then plotted to make the graph. The ranges shown at the bottom of the table, and the slopes of the lines in the graph, indicate how sensitive NPV is to changes in each input: *The larger the range and the steeper the slope, the more sensitive the NPV is to a change in the variable.* We see that NPV is very sensitive to changes in the sales price and variable cost, fairly sensitive to changes in the growth rate and units sold, and not very sensitive to changes in fixed cost or the WACC.

FIGURE 12-1 *Evaluating Risk: Sensitivity Analysis (Dollars in Thousands)*



Deviation from Base	NPV AT DIFFERENT DEVIATIONS FROM BASE					
	Sales Price	Variable Cost/Unit	Sales Growth	Year 1 Units Sold	Fixed Cost	WACC
−30%	($27,637)	$28,129	($ 5,847)	($ 4,675)	$9,540	$8,294
−15	(11,236)	16,647	(907)	246	7,353	6,674
0	5,166	5,166	5,166	5,166	5,166	5,166
15	21,568	(6,315)	12,512	10,087	2,979	3,761
30	37,970	(17,796)	21,269	15,007	792	2,450
Range	$65,607	$45,925	$27,116	$19,682	$8,748	$5,844

[8] "Important" here means that a relatively small change in an input leads to a large change in the output.

If we were comparing two projects, the one with the steeper sensitivity lines would be riskier, other things held constant, because that would indicate that relatively small errors in estimating the input variables would produce large errors in the NPV. Thus, sensitivity analysis provides useful insights into a project's risk.

Sensitivity analysis is easy with a computer spreadsheet model. We used the chapter model, which first calculated the NPVs and then drew the graph. To conduct such an analysis by hand would be very time consuming, and if the basic data were changed even slightly—say, the cost of the equipment was increased slightly—all of the calculations would have to be redone. With a spreadsheet, we would simply replace the old input with the new one, and presto, the analysis would be revised.

Scenario Analysis

In sensitivity analysis as described earlier we change one variable at a time. However, it is often useful to know what would happen to NPV if all of the inputs turn out to be either better or worse than expected. Also, if we can assign probabilities to the good, bad, and most likely (base-case) scenarios, then we can find the expected value and the standard deviation of the NPV.

Scenario Analysis
A risk analysis technique in which "bad" and "good" sets of financial circumstances are compared with a most likely, or base-case, situation.

Base-Case Scenario
An analysis in which all of the input variables are set at their most likely values.

Worst-Case Scenario
An analysis in which all of the input variables are set at their worst reasonably forecasted values.

Best-Case Scenario
An analysis in which all of the input variables are set at their best reasonably forecasted values.

Scenario analysis is a technique that allows for these extensions—it brings in the probabilities of changes in the key variables, and it allows us to change more than one variable at a time. In a scenario analysis, the financial analyst begins with the **base case,** which uses the most likely set of input values. Then he or she asks marketing, engineering, and other operating managers to specify a **worst-case scenario** (low unit sales, low sales price, high variable costs, and so on) and a **best-case scenario.** Often, the best and worst cases are defined as where there is a 25 percent probability of conditions being that good or bad, with a 50 percent probability of the base-case conditions. Obviously, conditions could actually take on other values, but such a scenario setup is useful to help people focus on the central issues in risk analysis.

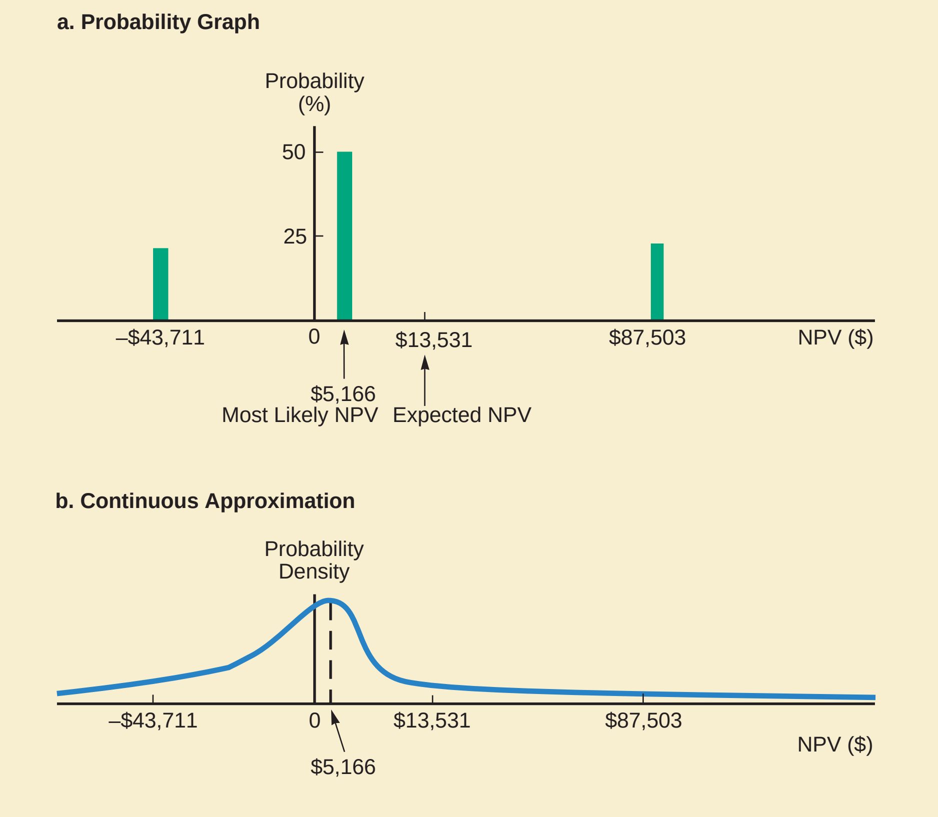
The best-case, base-case, and worst-case values for BQC's computer project are shown in Figure 12-2, along with plots of the data. If the product were highly successful, then the combination of a high sales price, low production costs, and high unit sales would result in a very high NPV, $87.5 million. However, if things turn out badly, then the NPV would be a negative $43.7 million. The graphs show the very wide range of possibilities, suggesting that this is a risky project. If the bad conditions materialize, this will not bankrupt the company—this is just one project for a large company. Still, losing $43.7 million would certainly hurt the stock price.

If we multiply each scenario's probability by the NPV under that scenario and then sum the products, we calculate the project's expected NPV, $13.531 million as shown in the data below Figure 12-2. We can also calculate the standard deviation of that NPV; it is $47.139 million. When we divide the standard deviation by the expected NPV we get the coefficient of variation, 3.48.[9] BQC's average project has a coefficient of variation of about 2.0, so the 3.48 indicates that this project is riskier than most of the firm's other projects.

BQC's WACC is 12 percent, so that rate should be used to find the NPV of an average-risk project. The computer project is riskier than average, so a higher discount rate should be used to find its NPV. There is no way to determine the "correct" discount rate—this is a judgment call. However, BQC's management generally adds 3 percent to the corporate WACC when it evaluates projects

[9] The coefficient of variation (CV) only makes sense when it is a positive number. A negative CV implies that the project's expected NPV is negative—which means the project would not be accepted.

FIGURE 12-2 *Scenario Analysis (Dollars in Thousands)*



Scenario	Probability	Unit Sales	Sales Price	Variable Costs	NPV
Best case	25%	26,000	$3.90	$1.47	$87,503
Base case	50	20,000	3.00	2.10	5,166
Worst case	25	14,000	2.10	2.73	(43,711)
			Expected NPV = Sum, probability times NPV		$13,531
			Standard deviation (calculated in *Excel* model)		$47,139
			Coefficient of variation = Standard deviation/Expected NPV		3.48

deemed to be risky. When the NPV was recalculated using a 15 percent WACC, the base-case NPV fell from $5.166 to $2.877 million and the expected NPV dropped from $13.531 to $10.740 million, so the project was still acceptable by the NPV criterion.[10]

Monte Carlo Simulation

Monte Carlo simulation, so named because this type of analysis grew out of work on the mathematics of casino gambling, is a version of scenario analysis, where the project is analyzed under a very large number of scenarios, or "runs." In each run, the computer picks at random a value for each variable—units sold,

Monte Carlo Simulation
A risk analysis technique in which probable future events are simulated on a computer, generating estimated rates of return and risk indexes.

[10] Note that both the risk and expected return can change when real options are considered. Indeed, as we demonstrate in Chapter 13, this happens for BQC's computer project.

GLOBAL PERSPECTIVES

Capital Budgeting Practices in the Asian/Pacific Region

A recent survey of executives in Australia, Hong Kong, Indonesia, Malaysia, the Philippines, and Singapore asked several questions about companies' capital budgeting practices. The study yielded the results summarized here.

Techniques for Evaluating Corporate Projects

Consistent with U.S. companies, most companies in this region evaluate projects using IRR, NPV, and payback. IRR usage ranged from 96 percent (in Australia) to 86 percent (in Hong Kong). NPV usage ranged from 96 percent (in Australia) to 81 percent (in the Philippines). Payback usage ranged from 100 percent (in Hong Kong and the Philippines) to 81 percent (in Indonesia).

Techniques for Estimating the Cost of Equity Capital

Recall from Chapter 10 that three basic approaches can be used to estimate the cost of equity: CAPM, dividend yield plus growth rate (DCF), and cost of debt plus a risk premium. The use of these methods varied considerably from country to country (see Table A). The CAPM is used most often by U.S. firms. This is also true for Australian firms, but not for the other Asian/Pacific firms, who instead more often use the DCF and risk premium approaches.

Techniques for Assessing Risk

Firms in the Asian/Pacific region rely heavily on scenario and sensitivity analyses. They also use decision trees and Monte Carlo simulation, but less frequently (see Table B).

TABLE A

Method	Australia	Hong Kong	Indonesia	Malaysia	Philippines	Singapore
CAPM	72.7%	26.9%	0.0%	6.2%	24.1%	17.0%
Dividend yield plus growth rate	16.4	53.8	33.3	50.0	34.5	42.6
Cost of debt plus risk premium	10.9	23.1	53.4	37.5	58.6	42.6

TABLE B

Risk Assessment Technique	Australia	Hong Kong	Indonesia	Malaysia	Philippines	Singapore
Scenario analysis	96%	100%	94%	80%	97%	90%
Sensitivity analysis	100	100	88	83	94	79
Decision tree analysis	44	58	50	37	33	46
Monte Carlo simulation	38	35	25	9	24	35

Source: Adapted from George W. Kester et al., "Capital Budgeting Practices in the Asia-Pacific Region: Australia, Hong Kong, Indonesia, Malaysia, Philippines, and Singapore," *Financial Practice and Education,* Vol. 9, no. 1 (Spring/Summer 1999), pp. 25–33.

sales price, variable costs per unit, and so on. Those values are then used to calculate the project's NPV, and that NPV is stored in the computer's memory. Next, a second set of input values is selected at random, and a second NPV is calculated. This process is repeated perhaps 1,000 times, generating 1,000 NPVs. The mean and standard deviation of the set of NPVs are determined. The mean, or average value, is used as a measure of the project's expected profitability, and the standard deviation (or perhaps the coefficient of variation) of the NPV is used as a measure of the project's risk.

Monte Carlo simulation is considerably more complex than scenario analysis, but simulation software packages make the process manageable. These packages may be used as add-ons to spreadsheet programs. Simulation is useful, but because of its complexity a detailed discussion is best left for advanced finance courses.[11]

SELF TEST

Explain briefly how one does a sensitivity analysis, and what the analysis is designed to show.

What is a scenario analysis, what is it designed to show, and how does it differ from a sensitivity analysis?

What is Monte Carlo simulation? How does a simulation analysis differ from a simple scenario analysis?

12.6 DIFFERENT CAPITAL STRUCTURES

The discount rate used in capital budgeting decisions is a weighted average of the costs of debt and equity, so if the mix of debt and equity changes, then so might the WACC. Generally, firms raise capital based on their optimal capital structures as described in Chapter 14, and they generally assume that the same structure applies to all capital budgeting projects. However, if a firm finances different assets in different ways, this should be taken into account in the capital budgeting process. For example, a kitchen equipment manufacturer might have a retail division that operates stores in malls and "outlets." This division might invest heavily in real estate that is used as collateral for loans, while the manufacturing division might have most of its capital tied up in specialized machinery, which is not good collateral. As a result, the retail division might finance with far more debt than the manufacturing division. In that case, the financial staff should calculate different WACCs for the two divisions, and those WACCs should be used for capital budgeting.[12]

SELF TEST

How might capital structure issues affect capital budgeting decisions?

12.7 INCORPORATING RISK INTO CAPITAL BUDGETING

Capital budgeting affects a firm's market and corporate risk, but it is extremely difficult to quantify these effects. Although we may be able to conclude that one project is riskier than another, it is difficult to *quantify* the difference. This makes it necessary to incorporate risk into capital budgeting decisions in a subjective

[11] To use Monte Carlo simulation, one needs both probability distributions for the inputs and correlation coefficients between each pair of inputs so that if the particular run has a low value for unit sales, the sales price will also be low (assuming positive correlation). It is often difficult to obtain "reasonable" values for the correlations, especially for new projects where no historical data are available. This has limited the use of simulation analysis.

[12] We will say more about the optimal capital structure and debt capacity in Chapter 14.

manner. Still, it is useful not only to build risk into the analysis, but also to recognize that conclusions should be used with caution and judgment.

Certainty Equivalent
The amount that would be paid with certainty that is equivalent to a risky cash flow.

Two primary methods are used to incorporate project risk into capital budgeting: (1) the certainty equivalent approach and (2) the risk-adjusted discount rate approach. When using the *certainty equivalent* approach we translate all cash inflows that are not known with certainty into their **certainty equivalents,** which means the certain (guaranteed) amounts that the decision maker would accept in lieu of the risky expected amounts. For example, an investor might be willing to exchange a risky expected cash flow of $100,000 for a sure $75,000, in which case $75,000 would be the investor's certainty equivalent for the risky $100,000. The riskier the flow, the lower its certainty equivalent. In capital budgeting, a project's most likely cash flows would be estimated as discussed earlier in the chapter, then the certainty equivalent of each cash flow would be determined, and then those certainty equivalent cash flows would be discounted at the risk-free rate to find the project's NPV. The main problem with this approach is that we have no way of estimating the certainty equivalents of the firm's stockholders, and those are the certainty equivalents that should be used in the analysis.

Risk-Adjusted Discount Rate
The discount rate that applies to a particular risky cash flow stream; the riskier the project's cash flow stream, the higher the discount rate.

The other method, which is generally the one used in practice, is the **risk-adjusted discount rate** approach. Here the discount rate is increased when evaluating riskier projects—the greater the risk, the higher the discount rate used in the analysis. Average-risk projects are discounted at the firm's WACC, higher-risk projects are discounted at a rate above the WACC, and lower-risk projects are discounted at a rate below the firm's WACC. Unfortunately, there is no precise way of specifying exactly how much higher or lower these discount rates should be. Risk adjustments are necessarily judgmental and somewhat arbitrary. Still, as noted earlier, most analysts are more comfortable estimating risk-adjusted discount rates than certainty equivalents, hence the risk-adjusted discount rate is the approach that is most often used in practice.

SELF TEST

What are *certainty equivalents* and *risk-adjusted discount rates?* How is each used to incorporate project risk into the capital budgeting decision process? Which is used most often in practice? Why?

Tying It All Together

The value of any asset depends on the amount, timing, and riskiness of the cash flows it is expected to produce. Therefore, to evaluate a proposed capital budgeting project we must estimate the project's cash flows and risk. First, cash flows are different from net income, and our focus must be on cash flows. Second, we need to focus on *incremental cash flows*, which are the *new* flows that will be added if the project is accepted. Some costs associated with the project may be *sunk costs,* which have already been expended and thus should be ignored. Third, *depreciation* is not a cash expense, hence it must be added back to estimate the incremental cash flow. Fourth, *externalities* must be considered when determining a project's cash flows. *Cannibalization*, which occurs if a new project takes sales and profits from an existing project, is an important externality. And fifth, the investment in *net operating working capital* must be recognized as an initial

cost, and the recovery of this working capital is a cash inflow at the end of the project's life.

Given the projected cash flows, we can calculate the NPV, IRR, MIRR, and payback. However, the cash flows, hence the NPV and other profitability measures, are not certain, so we must do a *risk analysis* before deciding to accept or reject the given project. *Sensitivity analysis, scenario analysis,* and *Monte Carlo simulation* are methods used to evaluate projects' risks. In theory, only *market risk* is relevant, but in practice *stand-alone* and *corporate risks* are also considered. If a project's risk is deemed to be higher or lower than average, then a *risk-adjusted WACC* should be used in the analysis. Note too that if different types of projects are financed with different mixes of debt and equity, this should be recognized, and different WACCs should be used when finding projects' NPVs.

SELF-TEST QUESTIONS AND PROBLEMS (Solutions Appear in Appendix A)

ST-1 **Key terms** Define each of the following terms:

a. Change in net operating working capital
b. Incremental cash flow; sunk cost; opportunity cost; externality; cannibalization effect
c. Replacement analysis
d. Stand-alone risk; corporate (within-firm) risk; market (beta) risk
e. Risk-adjusted cost of capital
f. Sensitivity analysis; base-case NPV
g. Scenario analysis; base-case scenario; worst-case scenario; best-case scenario
h. Monte Carlo simulation
i. Certainty equivalent; risk-adjusted discount rate

ST-2 **Project and risk analysis** As a financial analyst, you must evaluate a proposed project to produce printer cartridges. The equipment would cost $55,000, plus $10,000 for installation. Annual sales would be 4,000 units at a price of $50 per cartridge, and the project's life would be 3 years. Current assets would increase by $5,000 and payables by $3,000. At the end of 3 years the equipment could be sold for $10,000. Depreciation would be based on the MACRS 3-year class, so the applicable rates would be 33, 45, 15, and 7 percent. Variable costs would be 70 percent of sales revenues, fixed costs excluding depreciation would be $30,000 per year, the marginal tax rate is 40 percent, and the corporate WACC is 11 percent.

a. What is the required investment, that is, the Year 0 project cash flow?
b. What are the annual depreciation charges?
c. What is the terminal cash flow?
d. What are the net operating cash flows in Years 1, 2, and 3?
e. What are the annual project cash flows?
f. If the project is of average risk, what is its NPV, and should it be accepted?
g. Suppose management is uncertain about the exact unit sales. What would the project's NPV be if unit sales turned out to be 20 percent below forecast, but other inputs were as forecasted? Would this change the decision?
h. The CFO asks you to do a scenario analysis using these inputs:

	Probability	Unit Sales	VC%
Best case	25%	4,800	65%
Base case	50	4,000	70
Worst case	25	3,200	75

Other variables are unchanged. What are the expected NPV, its standard deviation, and the coefficient of variation? [Hint: To do the scenario analysis, you must change unit sales and VC% to the values specified for each scenario, get the scenario cash flows, and then find each scenario's NPV. Then you must calculate the project's expected NPV, standard deviation (SD), and coefficient of variation (CV). This is not difficult, but it would require a lot of calculations. You might want to look at the answer, but make sure you understand how it was developed.]

i. The firm's project CVs generally range from 1.0 to 1.5. A 3 percent risk premium is added to the WACC if the initial CV exceeds 1.5, and the WACC is reduced by 0.5 percent if the CV is 0.75 or less. Then a revised NPV is calculated. What WACC should be used for this project? What are the revised values for the NPV, standard deviation, and coefficient of variation? Would you recommend that the project be accepted?

QUESTIONS

12-1 Operating cash flows rather than accounting profits are listed in Table 12-1. Why do we focus on cash flows as opposed to net income in capital budgeting?

12-2 Explain why sunk costs should not be included in a capital budgeting analysis, but opportunity costs and externalities should be included. Give an example of each.

12-3 Explain why working capital is included in a capital budgeting analysis and how it is recovered at the end of a project's life.

12-4 Why are interest charges not deducted when a project's cash flows for use in a capital budgeting analysis are calculated?

12-5 Most firms generate cash inflows every day, not just once at the end of the year. In capital budgeting, should we recognize this fact by estimating daily project cash flows and then using them in the analysis? If we do not, are our results biased, and if so, would the NPV be biased up or down? Explain.

12-6 What are some differences in the analysis for a replacement project versus that for a new expansion project?

12-7 Distinguish among beta (or market) risk, within-firm (or corporate) risk, and stand-alone risk for a project being considered for inclusion in the capital budget.

12-8 In theory, market risk should be the only "relevant" risk. However, companies focus as much on stand-alone risk as on market risk. What are the reasons for the focus on stand-alone risk?

12-9 Define (a) sensitivity analysis, (b) scenario analysis, and (c) simulation analysis. If GE were considering two projects, one for $500 million to develop a satellite communications system and the other for $30,000 for a new truck, on which would the company be more likely to use a simulation analysis?

12-10 If you were the CFO of a company that had to decide on hundreds of potential projects every year, would you want to use sensitivity analysis and scenario analysis as described in the chapter, or would the amount of arithmetic required take too much time and thus not be cost effective? What involvement would nonfinancial people such as those in marketing, accounting, and production have in the analysis?

PROBLEMS

Easy Problems 1–3

12-1 **Required investment** Truman Industries is considering an expansion. The necessary equipment would be purchased for $9 million, and it would also require an additional $3 million investment in working capital. The tax rate is 40 percent.

a. What is the initial investment outlay?
b. The company spent and expensed $50,000 on research related to the project last year. Would this change your answer? Explain.
c. The company plans to use a building it owns but is not now using to house the project. The building could be sold for $1 million after taxes and real estate commissions. How would that affect your answer?

12-2 **Operating cash flow** Eisenhower Communications is trying to estimate the first-year net operating cash flow (at Year 1) for a proposed project. The financial staff has collected the following information on the project:

Sales revenues	$10 million
Operating costs (excluding depreciation)	7 million
Depreciation	2 million
Interest expense	2 million

The company has a 40 percent tax rate, and its WACC is 10 percent.

a. What is the project's operating cash flow for the first year (t = 1)?
b. If this project would cannibalize other projects by $1 million of cash flow before taxes per year, how would this change your answer to part a?
c. Ignore part b. If the tax rate dropped to 30 percent, how would that change your answer to part a?

12-3 **Net salvage value** Kennedy Air Services is now in the final year of a project. The equipment originally cost $20 million, of which 80 percent has been depreciated. Kennedy can sell the used equipment today for $5 million, and its tax rate is 40 percent. What is the equipment's after-tax net salvage value?

Intermediate Problems 4–8

12-4 **Depreciation methods** Kristin is evaluating a capital budgeting project that should last for 4 years. The project requires $800,000 of equipment. She is unsure what depreciation method to use in her analysis, straight-line or the 3-year MACRS accelerated method. Under straight-line depreciation, the cost of the equipment would be depreciated evenly over its 4-year life (ignore the half-year convention for the straight-line method). The applicable MACRS depreciation rates are 33, 45, 15, and 7 percent as discussed in Appendix 12A. The company's WACC is 10 percent, and its tax rate is 40 percent.

a. What would the depreciation expense be each year under each method?
b. Which depreciation method would produce the higher NPV, and how much higher would it be?

12-5 **Scenario analysis** Huang Industries is considering a proposed project whose estimated NPV is $12 million. This estimate assumes that economic conditions will be "average." However, the CFO realizes that conditions could be better or worse, so she performed a scenario analysis and obtained these results:

Economic Scenario	Probability of Outcome	NPV
Recession	0.05	($70 million)
Below average	0.20	(25 million)
Average	0.50	12 million
Above average	0.20	20 million
Boom	0.05	30 million

Calculate the project's expected NPV, standard deviation, and coefficient of variation.

12-6 **New project analysis** You must evaluate a proposed spectrometer for the R&D department. The base price is $140,000, and it would cost another $30,000 to modify the equipment for special use by the firm. The equipment falls into the MACRS 3-year class and would be sold after 3 years for $60,000. The applicable depreciation rates are 33, 45, 15, and 7 percent as discussed in Appendix 12A. The equipment would require an $8,000 increase in working capital (spare parts inventory). The project would have no effect on revenues, but it should save the firm $50,000 per year before-tax labor costs. The firm's marginal federal-plus-state tax rate is 40 percent.

a. What is the net cost of the spectrometer, that is, what is the Year 0 project cash flow?
b. What are the net operating cash flows in Years 1, 2, and 3?
c. What is the terminal cash flow?
d. If the WACC is 12 percent, should the spectrometer be purchased?

12-7 **New project analysis** You must evaluate a proposal to buy a new milling machine. The base price is $108,000, and shipping and installation costs would add another $12,500. The machine falls into the MACRS 3-year class, and it would be sold after 3 years for $65,000. The applicable depreciation rates are 33, 45, 15, and 7 percent as discussed in Appendix 12A. The machine would require a $5,500 increase in working capital (increased inventory less increased accounts payable). There would be no effect on revenues, but pre-tax labor costs would decline by $44,000 per year. The marginal tax rate is 35 percent, and the WACC is 12 percent. Also, the firm spent $5,000 last year investigating the feasibility of using the machine.

a. How should the $5,000 spent last year be handled?
b. What is the net cost of the machine for capital budgeting purposes, that is, the Year 0 project cash flow?
c. What are the net operating cash flows during Years 1, 2, and 3?

d. What is the terminal year cash flow?
e. Should the machine be purchased? Explain your answer.

12-8 Project risk analysis The Butler-Perkins Company (BPC) must decide between two mutually exclusive projects. Each costs $6,750 and has an expected life of 3 years. Annual project cash flows begin 1 year after the initial investment, and are subject to the following probability distributions:

PROJECT A		PROJECT B	
Probability	Cash Flows	Probability	Cash Flows
0.2	$6,000	0.2	$ 0
0.6	6,750	0.6	6,750
0.2	7,500	0.2	18,000

BPC has decided to evaluate the riskier project at 12 percent and the less-risky project at 10 percent.

a. What is each project's expected annual cash flow? Project B's standard deviation (σ_B) is $5,798 and its coefficient of variation (CV_B) is 0.76. What are the values of σ_A and CV_A?
b. Based on their risk-adjusted NPVs, which project should BPC choose?
c. If you knew that Project B's cash flows were negatively correlated with the firm's other cash flow, whereas Project A's flows were positively correlated, how might this affect the decision? If Project B's cash flows were negatively correlated with gross domestic product (GDP), while A's flows were positively correlated, would that influence your risk assessment?

Challenging Problems 9–10

12-9 Scenario analysis Your firm, Agrico Products, is considering a tractor that would have a net cost of $36,000, would increase pre-tax operating cash flows before taking account of depreciation by $12,000 per year, and would be depreciated on a straight-line basis to zero over 5 years at the rate of $7,200 per year, beginning the first year. (Thus annual cash flows would be $12,000, before taxes, plus the tax savings that result from $7,200 of depreciation.) The managers are having a heated debate about whether the tractor would actually last 5 years. The controller insists that she knows of tractors that have lasted only 4 years. The treasurer agrees with the controller, but he argues that most tractors actually do give 5 years of service. The service manager then states that some actually last for as long as 8 years.

Given this discussion, the CFO asks you to prepare a scenario analysis to determine the importance of the tractor's life on the NPV. Use a 40 percent marginal federal-plus-state tax rate, a zero salvage value, and a WACC of 10 percent. Assuming each of the indicated lives has the same probability of occurring (probability = 1/3), what is the tractor's expected NPV? (Hint: Here straight-line depreciation is based on the MACRS class life of the tractor and is not affected by the actual life. Also, ignore the half-year convention for this problem.)

12-10 New project analysis Holmes Manufacturing is considering a new machine that costs $250,000 and would reduce pre-tax manufacturing costs by $90,000 annually. Holmes would use the 3-year MACRS method to depreciate the machine, and management thinks the machine would have a value of $23,000 at the end of its 5-year operating life. The applicable depreciation rates are 33, 45, 15, and 7 percent as discussed in Appendix 12A. Working capital would increase by $25,000 initially, but it would be recovered at the end of the project's 5-year life. Holmes's marginal tax rate is 40 percent, and a 10 percent WACC is appropriate for the project.

a. Calculate the project's NPV, IRR, MIRR, and payback.
b. Assume management is unsure about the $90,000 cost savings—this figure could deviate by as much as plus or minus 20 percent. What would the NPV be under each of these situations?
c. Suppose the CFO wants you to do a scenario analysis with different values for the cost savings, the machine's salvage value, and the working capital (WC) requirement. She asks you to use the following probabilities and values in the scenario analysis:

Scenario	Probability	Cost Savings	Salvage Value	WC
Worst case	0.35	$ 72,000	$18,000	$30,000
Base case	0.35	90,000	23,000	25,000
Best case	0.30	108,000	28,000	20,000

Calculate the project's expected NPV, its standard deviation, and its coefficient of variation. Would you recommend that the project be accepted?

COMPREHENSIVE/SPREADSHEET PROBLEM

12-11 **New project analysis** You must analyze a potential new product—a caulking compound that Cory Materials' R&D people developed for use in the residential construction industry. Cory's marketing manager thinks they can sell 115,000 tubes per year at a price of $3.25 each for 3 years, after which the product will be obsolete. The required equipment would cost $150,000, plus another $25,000 for shipping and installation. Current assets (receivables and inventories) would increase by $35,000, while current liabilities (accounts payable and accruals) would rise by $15,000. Variable costs would be 60 percent of sales revenues, fixed costs (exclusive of depreciation) would be $70,000 per year, and the fixed assets would be depreciated under MACRS with a 3-year life. (Refer to Appendix 12A for MACRS depreciation rates.) When production ceases after 3 years, the equipment should have a market value of $15,000. Cory's tax rate is 40 percent, and it uses a 10 percent WACC for average-risk projects.

a. Find the required Year 0 investment, the annual after-tax operating cash flows, and the terminal year cash flow, and then calculate the project's NPV, IRR, MIRR, and payback. Assume at this point that the project is of average risk.
b. Suppose you now learn that R&D costs for the new product were $30,000, and those costs were incurred and expensed for tax purposes last year. How would this affect your estimate of NPV and the other profitability measures?
c. If the new project would reduce cash flows from Cory's other projects, and if the new project were to be housed in an empty building that Cory owns and could sell if it chose to, how would those factors affect the project's NPV?
d. Are this project's cash flows likely to be positively or negatively correlated with returns on Cory's other projects and with the economy, and should this matter in your analysis? Explain.
e. **Spreadsheet assignment: at instructor's option** Construct a spreadsheet that calculates the cash flows, NPV, IRR, payback, and MIRR.
f. The CEO expressed concern that some of the base-case inputs might be too optimistic or too pessimistic, and he wants to know how the NPV would be affected if these 6 variables were all 20 percent better or 20 percent worse than the base-case level: unit sales, sales price, variable costs, fixed costs, WACC, and equipment cost. Hold other things constant when you consider each variable, and construct a sensitivity graph to illustrate your results.
g. Do a scenario analysis based on the assumption that there is a 25 percent probability that each of the 6 variables itemized in part f would turn out to have their best-case values as calculated in part f, a 50 percent probability that all will have their base-case values, and a 25 percent probability that all will have their worst-case values. The other variables remain at base-case levels. Calculate the expected NPV, the standard deviation of NPV, and the coefficient of variation.
h. Does Cory's management use the risk-adjusted discount rate or the certainty equivalent method to adjust for project risk? Explain what it does and how it would use the alternative method.

Integrated Case

Allied Food Products

12-12 **Capital budgeting and cash flow estimation** Allied Food Products is considering expanding into the fruit juice business with a new fresh lemon juice product. Assume that you were recently hired as assistant to the director of capital budgeting, and you must evaluate the new project.

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

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

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

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

a. Allied has a standard form that is used in the capital budgeting process; see Table IC12-1. Part of the table has been completed, but you must replace the blanks with the missing numbers. Complete the table in the following steps:
   (1) Fill in the blanks under Year 0 for the initial investment outlay.
   (2) Complete the table for unit sales, sales price, total revenues, and operating costs excluding depreciation.
   (3) Complete the depreciation data.
   (4) Now complete the table down to NOPAT, and then down to operating cash flows.
   (5) Now fill in the blanks under Year 4 for the terminal cash flows, and complete the project cash flow line. Discuss working capital. What would have happened if the machinery were sold for less than its book value?

b. (1) Allied uses debt in its capital structure, so some of the money used to finance the project will be debt. Given this fact, should the projected cash flows be revised to show projected interest charges? Explain.
   (2) Suppose you learned that Allied had spent $50,000 to renovate the building last year, expensing these costs. Should this cost be reflected in the analysis? Explain.
   (3) Now suppose you learned that Allied could lease its building to another party and earn $25,000 per year. Should that fact be reflected in the analysis? If so, how?
   (4) Now assume that the lemon juice project would take away profitable sales from Allied's fresh orange juice business. Should that fact be reflected in your analysis? If so, how?

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

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

e. (1) What are the three levels, or types, of project risk that are normally considered?
   (2) Which type is most relevant?
   (3) Which type is easiest to measure?
   (4) Are the three types of risk generally highly correlated?

f. (1) What is sensitivity analysis?
   (2) How would one perform a sensitivity analysis on the unit sales, salvage value, and WACC for the project? Assume that each of these variables deviates from its base-case, or expected, value by plus and minus 10, 20, and 30 percent. Explain how you would calculate the NPV, IRR, MIRR, and payback for each case, but don't do the analysis unless your instructor asks you to.
   (3) What is the primary weakness of sensitivity analysis? What are its primary advantages?

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

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

h. The expected cash flows, considering inflation (in thousands of dollars), are given in Table IC12-2. Allied's WACC is 10 percent. Assume that you are confident about the estimates of all the variables that affect the cash flows except unit sales. If product acceptance is poor, sales would be only 75,000 units a year, while a strong consumer response would produce sales of 125,000 units. In either case, cash costs would still amount to 60 percent of revenues. You believe that there is a 25 percent chance of poor acceptance, a 25 percent chance of excellent acceptance, and a 50 percent chance of average acceptance (the base case). Provide numbers only if you are using a computer model.
   (1) What is the worst-case NPV? The best-case NPV?
   (2) Use the worst, most likely (or base), and best-case NPVs, with their probabilities of occurrence, to find the project's expected NPV, standard deviation, and coefficient of variation.

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

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

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

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

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

TABLE IC12-1 *Allied's Lemon Juice Project (Total Cost in Thousands)*

End of Year:	0	1	2	3	4
I. INVESTMENT OUTLAY					
Equipment cost					
Installation					
Increase in inventory					
Increase in accounts payable					
Total net investment					
II. OPERATING CASH FLOWS					
Unit sales (thousands)			100		
Price/unit		$ 2.00	$ 2.00		
Total revenues					$200.0
Operating costs excluding depreciation			$120.0		
Depreciation				36.0	16.8
Total costs		$199.2	$228.0		
Operating income before taxes (EBIT)				$44.0	
Taxes on operating income		0.3			25.3
Operating income after taxes (NOPAT)				$26.4	
Depreciation		79.2		36.0	
Operating cash flow	$ 0.0	$ 79.7			$ 54.7
III. TERMINAL YEAR CASH FLOWS					
Return of net operating working capital					
Salvage value					
Tax on salvage value					
Total termination cash flows					
IV. PROJECT CASH FLOWS					
Project cash flow	($260.0)				$ 89.7
V. RESULTS					
NPV =					
IRR =					
MIRR =					
Payback =					

TABLE IC12-2 *Allied's Lemon Juice Project Considering 5 Percent Inflation (in Thousands)*

	YEAR				
	0	**1**	**2**	**3**	**4**
Investment in:					
Fixed assets	($240)				
Net operating working capital	(20)				
Unit sales (thousands)		100	100	100	100
Sales price (dollars)		$2.100	$2.205	$2.315	$2.431
Total revenues		$210.0	$220.5	$231.5	$243.1
Cash operating costs (60%)		126.0	132.3	138.9	145.9
Depreciation		79.2	108.0	36.0	16.8
Operating income before taxes (EBIT)		$ 4.8	($ 19.8)	$ 56.6	$ 80.4
Taxes on operating income (40%)		1.9	(7.9)	22.6	32.1
Operating income after taxes (NOPAT)		$ 2.9	($ 11.9)	$ 34.0	$ 48.3
Plus depreciation		79.2	108.0	36.0	16.8
Operating cash flow		$ 82.1	$ 96.1	$ 70.0	$ 65.1
Salvage value					25.0
Tax on SV (40%)					(10.0)
Recovery of NOWC					20.0
Project cash flow	($260)	$ 82.1	$ 96.1	$ 70.0	$100.1
Cumulative cash flows for payback:	(260.0)	(177.9)	(81.8)	(11.8)	88.3
Compounded inflows for MIRR:		109.2	116.3	77.0	100.1
Terminal value of inflows:					402.6
NPV	= $15.0				
IRR	= 12.6%				
MIRR	= 11.6%				

cyberproblem

Please go to the ThomsonNOW Web site to access the Cyberproblems.

APPENDIX 12A

Tax Depreciation

Depreciation is covered in detail in accounting courses, so we provide here only some basic information that is needed for capital budgeting. First, note that accountants generally calculate each asset's depreciation in two ways—they generally use straight line to figure the depreciation used for reporting profits to investors, but they use depreciation rates provided by the Internal Revenue Service (IRS) and called MACRS (Modified Accelerated Cost Recovery System) rates when they calculate depreciation for tax purposes. In capital budgeting, we are concerned with tax depreciation, so the relevant rates are the MACRS rates.

Under MACRS, each type of fixed asset is assigned to a "class" and is then depreciated over the asset's **class life**. Table 12A-1 provides class lives for different types of assets as they existed in 2005. Next, as we show in Table 12A-2, MACRS specifies **annual depreciation rates** for assets in each class life. Real properties (buildings) are depreciated on a straight-line basis over 27.5 or 39 years, but all other assets are depreciated over shorter periods and on an accelerated basis, with high depreciation charges in the early years and less depreciation in the later years. The IRS tables are based on the **half-year convention,** where it is assumed that the asset is placed in service halfway through the first year and is taken out of service halfway through the year after its class life.

Class Life
The specified life of assets under the MACRS system.

Annual Depreciation Rates
The annual expense accountants charge against income for "wear and tear" of an asset. For tax purposes, the IRS provides that appropriate MACRS rates be used that are dependent on an asset's class life.

Half-Year Convention
Assumes assets are used for half of the first year and half of the last year.

In the following example, we calculate depreciation on the equipment that BQC would use for the computer project discussed in Chapter 12. That equipment would be classified as a 5-year asset with a cost of $8 million. In developing the tables, the IRS assumes that the machinery would be used for only six months of the year in which it is acquired, for 12 months in each of the next four years, and then for six months of the sixth year. Here are the depreciation charges, in thousands, that could be deducted for tax purposes based on MACRS:

Year	1	2	3	4	5	6
Rate	20%	32%	19%	12%	11%	6%
Depreciation	$1,600	$2,560	$1,520	$960	$880	$480

The total of the annual depreciation charges equals the $8 million cost of the asset, but it would be taken over six years and thus would affect cash flows over those six years.

Of course, BQC only plans to use the equipment for four years, so the allowable depreciation shown above for Years 5 and 6 will not enter into BQC's capital budgeting analysis.

TABLE 12A-1 *Major Classes and Asset Lives for MACRS*

Class	Type of Property
3-year	Certain special manufacturing tools
5-year	Automobiles, light-duty trucks, computers, and certain special manufacturing equipment
7-year	Most industrial equipment, office furniture, and fixtures
10-year	Certain longer-lived types of equipment
27.5-year	Residential rental real property such as apartment buildings
39-year	All nonresidential real property, including commercial and industrial buildings

TABLE 12A-2 *Recovery Allowance Percentage for Personal Property*

	CLASS OF INVESTMENT			
Ownership Year	**3-Year**	**5-Year**	**7-Year**	**10-Year**
1	33%	20%	14%	10%
2	45	32	25	18
3	15	19	17	14
4	7	12	13	12
5		11	9	9
6		6	9	7
7			9	7
8			4	7
9				7
10				6
11				3
	100%	100%	100%	100%

Notes:

a. We developed these recovery allowance percentages based on the 200 percent declining balance method prescribed by MACRS, with a switch to straight-line depreciation at some point in the asset's life. For example, consider the 5-year recovery allowance percentages. The straight-line percentage would be 20 percent per year, so the 200 percent declining balance multiplier is 2.0(20%) = 40% = 0.4. However, because the half-year convention applies, the MACRS percentage for Year 1 is 20 percent. For Year 2, there is 80 percent of the depreciable basis remaining to be depreciated, so the recovery allowance percentage is 0.40(80%) = 32%. In Year 3, 20% + 32% = 52% of the depreciation has been taken, leaving 48 percent, so the percentage is 0.4(48%) = 19%. In Year 4, the percentage is 0.4(29%) = 12%. After 4 years, straight-line depreciation exceeds the declining balance depreciation, so a switch is made to straight-line (this is permitted under the law). However, the half-year convention must also be applied at the end of the class life, and the remaining 17 percent of depreciation must be taken (amortized) over 1.5 years. Thus, the percentage in Year 5 is 17%/1.5 ≈ 11%, and in Year 6, 17% − 11% = 6%. Although the tax tables carry the allowance percentages out to two decimal places, we have rounded to the nearest whole number for ease of illustration.

b. Residential rental property (apartments) is depreciated over a 27.5-year life, whereas commercial and industrial structures are depreciated over 39 years. In both cases, straight-line depreciation must be used. The depreciation allowance for the first year is based, pro rata, on the month the asset was placed in service, with the remainder of the first year's depreciation being taken in the 28th or 40th year.