Fundamentals of Corporate Finance, 2/e

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Chapter 11: Cash Flows and Capital Budgeting

Learning Objectives

1. EXPLAIN WHY INCREMENTAL AFTER-TAX FREE CASH FLOWS ARE RELEVANT IN EVALUATING A PROJECT AND CALCULATE THEM FOR A PROJECT.
2. DISCUSS THE FIVE GENERAL RULES FOR INCREMENTAL AFTER-TAX FREE CASH FLOW CALCULATIONS AND EXPLAIN WHY CASH FLOWS STATED IN NOMINAL (REAL) DOLLARS SHOULD BE DISCOUNTED USING A NOMINAL (REAL) DISCOUNT RATE.

Learning Objectives

3. DESCRIBE HOW DISTINGUISHING BETWEEN VARIABLE AND FIXED COSTS CAN BE USEFUL IN FORECASTING OPERATING EXPENSES.
4. EXPLAIN THE CONCEPT OF EQUIVALENT ANNUAL COST AND USE IT TO COMPARE PROJECTS WITH UNEQUAL LIVES, DECIDE WHEN TO REPLACE AN EXISTING ASSET, AND CALCULATE THE OPPORTUNITY COST OF USING AN EXISTING ASSET.

Learning Objectives

5. DETERMINE THE APPROPRIATE TIME TO HARVEST AN ASSET.

Variable Costs, Fixed Costs, and Project Risk

- CASH FLOWS AND PROFIT
  - **To provide adequate net cash flow, the average selling price of a unit should be not be less than the sum of**
    - cost of making the unit
    - fixed cost (overhead) for the unit
    - adequate return (in $) for the unit

Calculating Project Cash Flows

- THE IMPORTANCE OF CAPITAL BUDGETING
  - **Capital budgeting involves estimating the NPV of the cash flows a project is expected to produce in the future.**
  - **All of the cash flow estimates are forward-looking. Cash flows that have already occurred or will occur regardless of the outcome of the capital budgeting decision are not considered.**

Calculating Project Cash Flows

- INCREMENTAL FREE CASH FLOWS
  - **Only incremental after-tax cash flow is used in an NPV analysis. This is the amount of additional unrestricted free cash flow (FCP) a firm will have if the project is adopted.**

    FCF project = FCF with project – FCF without project (11.1)

Calculating Project Cash Flows

- INCREMENTAL FREE CASH FLOWS
  - **Free cash flow is cash remaining after a firm has made necessary project-related expenditures for working capital and long-term assets.**

    It is cash a firm can distribute to creditors and stockholders.

Calculating Project Cash Flows

- PROJECT-RELATED EXPENDITURES
  - **Working Capital**

    inventory

    accounts receivable
  - **Long-term Assets**

    plant

    equipment

    licenses

Calculating Project Cash Flows

- FCF CALCULATION
  - **FCF = [(Revenue – Op Exp – D&A) x (1 – t)]**
    + D&A – Cap Exp – Add WC (11.2)

    Op Exp = operating expenses

    D&A = depreciation & amortization

    Cap Exp = capital expenditures

    Add WC = additional working capital

    t = tax rate

Calculating Project Cash Flows

- FCF EXAMPLE
  - **A new trucks will increase revenues by $50,000 and operating expenses by $30,000 per year. It will be depreciated over 3 years at $10,000 per year. Your firm's marginal tax rate is 35%. Capital expenditures will be $3,000 annually but no additional working capital will be needed. Calculate the yearly free cash flow.**

$$FCF = [(\$50{,}000 - \$30{,}000 - \$10{,}000) \times (1 - 0.35)]$$

$$+ \$10{,}000 - \$3{,}000 - \$0 = \$13{,}500$$

The Free Cash-Flow Calculation

EXHIBIT 11.1 **The Free Cash Flow Calculation**

This exhibit shows how the incremental after-tax free cash flow (FCF) for a project is calculated. The FCF equals the change in the firm's cash income, excluding interest expense, that the project is responsible for, plus depreciation and amortization for the project, minus all required capital expenditures and investments in working capital. FCF also equals the incremental after-tax cash flow from operations minus the capital expenditures and investments in working capital required for the project.

Explanation	Calculation	Formula
The change in the firm's cash income, excluding interest expense, resulting from the project.	Revenue	Revenue
	−Cash operating expenses	−Op Ex
	Earnings before interest, taxes, depreciation, and amortization	EBITDA
	−Depreciation and amortization	−D&A
	Operating profit	EBIT
	× (1 − Firm's marginal tax rate)	$\times(1-t)$
	Net operating profit after tax	NOPAT
Adjustments for the impact of depreciation and amortization and investments on FCF.	+ Depreciation and amortization	+D&A
	Cash flow from operations	CF Opns
	− Capital expenditures	−Cap Exp
	− Additions to working capital	−Add WC
	Free cash flow	FCF

Calculating Project Cash Flows

- FCF CALCULATION
  - **Compute the project's incremental cash flow from operations (CF Opns). This is cash flow remaining after operating expenses and taxes have been paid.**
  - **Subtract expenditures for the project's capital assets (Cap Exp) and working capital (Add WC).**
  - **FCF is a project's after-tax cash flow over and above what is necessary for project-related expenditures.**

FCF Calculation Worksheet for the Performing Arts Center Project

EXHIBIT 11.2 **FCF Calculation Worksheet for the Performing Arts Center Project**

A free cash flow (FCF) calculation table is useful in evaluating a project. It helps organize the calculations and ensure that they are completed correctly.

	Year 0	Years 1 to 9	Year 10
Revenue			
−Op Ex	_____	_____	_____
EBITDA			
−D&A	_____	_____	_____
EBIT			
$\times(1-t)$	_____	_____	_____
NOPAT			
+D&A	_____	_____	_____
CF Opns			
−Cap Exp			
−Add WC	_____	_____	_____
FCF			

Completed FCF Calculation Worksheet for the Performing Arts Center Project

EXHIBIT 11.3 **Completed FCF Calculation Worksheet for the Performing Arts Center Project**

The completed calculation table shows how the incremental after-tax free cash flows (FCF) for the performing arts center project are computed, along with the NPV for that project when the cost of capital is 10 percent.

	Year 0	Years 1 to 9	Year 10
Revenue		$14,100,000	$14,100,000
−Op Ex		8,460,000	8,460,000
EBITDA		$ 5,640,000	$ 5,640,000
−D&A		1,000,000	1,000,000
EBIT		$ 4,640,000	$ 4,640,000
$\times(1-t)$		0.70	0.70
NOPAT		$ 3,248,000	$ 3,248,000
+D&A		1,000,000	1,000,000
CF Opns		$ 4,248,000	$ 4,248,000
−Cap Exp	$10,000,000	0	0
−Add WC	1,000,000	0	−1,000,000
FCF	−$11,000,000	$ 4,248,000	$ 5,248,000
NPV @ 10%	$15,487,664		

Calculating Project Cash Flows

- FCF CALCULATION
  - **The "stand-alone principle" is the idea that cash flows from a project can be evaluated independently of a firm's other cash flows.**

    It treats each project as a separate firm with its own revenue, expenses, and investment requirements.

Calculating Project Cash Flows

- CASH FLOWS FROM OPERATIONS
  - **The incremental cash flow from operations, CF Opns, equals the incremental net operating profits after tax (NOPAT) plus the depreciation and amortization (D&A) associated with the project**

Calculating Project Cash Flows

- CASH FLOWS FROM OPERATIONS
  - **The firm's marginal tax rate (*t*) is used to calculate NOPAT because net cash flows from a new project are assumed to be incremental to the firm**

Calculating Project Cash Flows

- CASH FLOWS FROM OPERATIONS
  - **Depreciation and amortization (D&A) associated with the project are added to NOPAT when calculating CF Opns.**
  - **D&A expense is deducted for calculating taxable income, but no cash outflow is involved. It is added to NOPAT to determine the cash flow from operations.**

Calculating Project Cash Flows

- FCF VERSUS ACCOUNTING EARNINGS
  - **A project's impact a firm's value and stock price does not depend on how the project affects accounting earnings. It depends on how the project affects free cash flows.**
  - **Accounting earnings may differ from cash flows for a number of reasons, making accounting earnings an unreliable measure of the costs and benefits of a project.**

Calculating Project Cash Flows

- FCF VERSUS ACCOUNTING EARNINGS
  - **Accounting earnings are reduced by non-cash charges, such as depreciation and amortization**
  - **These charges account for the deterioration of a business' long-term assets but do not involve a cash outlay at the time the expense is incurred**

Using Excel – Performing Arts Center Project

USING EXCEL

PERFORMING ARTS CENTER PROJECT

Cash flow calculations for capital budgeting problems are best set up and solved using a spreadsheet application. Here is the setup for the performing arts center project:

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
1	**Key Assumptions:**																					
2	Life of the project (Years)	10																				
3	Number of new boxes	4																				
4	Annual incremental revenue per box	$400,000																				
5	Number of new seats	5,000																				
6	Annual incremental revenue per seat	$2,500																				
7	Incremental expense (% of revenue)	60%																				
8	Construction cost (Cap Exp)*	$10,000																				
9	Depreciation (per year)*	$1,000																				
10	Additional investment in Year 0 (Add WC)*	$1,000																				
11	WC to be recovered in Year 10*	($1,000)																				
12	Tax rate	30%																				
13	Cost of capital	10%																				
14	Note: * denotes figures in millions of dollars																					
15																						
16	**Cash Flow Calculations for Performing Arts Center Project ($ millions)**																					
17												Year										
18		0		1	2	3	4		5	6	7		8	9		10						
19	Revenue			$14,100	$14,100	$14,100	$14,100		$14,100	$14,100	$14,100		$14,100	$14,100		$14,100						
20	Operating Expenses			8,460	8,460	8,460	8,460		8,460	8,460	8,460		8,460	8,460		8,460						
21	EBITDA			$5,640	$5,640	$5,640	$5,640		$5,640	$5,640	$5,640		$5,640	$5,640		$5,640						
22	Less: Depreciation & Amortization			1,000	1,000	1,000	1,000		1,000	1,000	1,000		1,000	1,000		1,000						
23	EBIT			$4,640	$4,640	$4,640	$4,640		$4,640	$4,640	$4,640		$4,640	$4,640		$4,640						
24	Less Taxes			1,392	1,392	1,392	1,392		1,392	1,392	1,392		1,392	1,392		1,392						
25	NOPAT			$3,248	$3,248	$3,248	$3,248		$3,248	$3,248	$3,248		$3,248	$3,248		$3,248						
26																						
27	Plus: Depreciation & Amortization			1,000	1,000	1,000	1,000		1,000	1,000	1,000		1,000	1,000		1,000						
28	Cash Flows from Operations			$4,248	$4,248	$4,248	$4,248		$4,248	$4,248	$4,248		$4,248	$4,248		$4,248						
29	Less: Capital Expenditures	$10,000		0	0	0	0		0	0	0		0	0		0						
30	Less: Changes in Working Capital	$1,000		0	0	0	0		0	0	0		0	0		(1,000)						
31																						
32	**Free Cash Flow**	($11,000)		$4,248	$4,248	$4,248	$4,248		$4,248	$4,248	$4,248		$4,248	$4,248		$5,248						
33																						
34	**NPV**	$15,488																				
35																						

The following is the formula setup for the performing arts center project. As we did in Exhibit 11.3, we have combined years 1 through 9 in a single column to save space. As mentioned in previous chapters, notice that none of the values in the actual worksheet are hard coded but instead use references from the key assumptions list, or specific formulas. This allows for an easy analysis of the impact of changes in the assumptions.

	A	B	C	D	E	V
1	**Key Assumptions:**					
2	Life of the project (Years)	10				
3	Number of new boxes	4				
4	Annual incremental revenue per box	400000				
5	Number of new seats	5000				
6	Annual incremental revenue per seat	2500				
7	Incremental expense (% of revenue)	0.6				
8	Construction cost (Cap Exp)*	10000				
9	Depreciation (per year)*	=$B$8/$B$2				
10	Additional investment in Year 0 (Add WC)*	1000				
11	WC to be recovered in Year 10*	(1000)				
12	Tax rate	0.3				
13	Cost of capital	0.1				
14	Note: * denotes figures in millions of dollars					
15						
16	**Cash Flow Calculations for Performing Arts Center Project ($ millions)**					
17				Year		
18		0		1-9		10
19	Revenue			=($B$3*$B$4+$B$5*$B$6)/1000		=($B$3*$B$4+$B$5*$B$6)/1000
20	Operating Expenses			=$B$7*D19		=$B$7*V19
21	EBITDA			=D19-D20		=V19-V20
22	Less: Depreciation & Amortization			=$B$9		=$B$9
23	EBIT			=D21-D22		=V21-V22
24	Less Taxes			=D23*$B$12		=V23*$B$12
25	NOPAT			=D23-D24		=V23-V24
26						
27	Plus: Depreciation & Amortization			=$B$9		=$B$9
28	Cash Flows from Operations			=D25+D27		=V25+V27
29	Less: Capital Expenditures	=$B		0		0
30	Less: Changes in Working Capital	=$B$10		0		=$B$11
31						
32	**Free Cash Flow**	=$B28-$B29-$B30		=D28-D29-D30		=V28-V29-V30
33						
34	**NPV**	=NPV($B13, D32:V32)+$B32				
35						

Estimating Cash Flows in Practice

- FIVE GENERAL RULES FOR INCREMENTAL CASH-FLOW CALCULATIONS

1. **Include cash flows only**

   Do not include allocated costs or overhead unless they occur because of the project.

2. **Include the impact of the project on cash flows of other product lines**

   If a project is expected to affect cash flows of another project, include the expected impact on the cash flows of the other project in the analysis.

Estimating Cash Flows in Practice

- FIVE GENERAL RULES FOR INCREMENTAL CASH-FLOW CALCULATIONS

3. **Include all opportunity costs**

   Benefits that could have been earned by choosing another project are a cost to the firm.

4. **Ignore sunk costs**

   Sunk costs have already been incurred or committed to and will not be influenced by the project.

Estimating Cash Flows in Practice

- FIVE GENERAL RULES FOR INCREMENTAL CASH-FLOW CALCULATIONS

5. **Include only after-tax cash flows**

   Incremental pre-tax cash flows earnings of a project only matter to the extent that they determine the free after-tax cash flows.

Adjusted FCF Calculations and NPV for the Performing Arts Center

EXHIBIT 11.4 **Adjusted FCF Calculations and NPV for the Performing Arts Center Project**

The adjustments described in the text result in changes in the FCF calculations and a different NPV for the performing arts center project.

	Year 0	Years 1 to 9	Year 10
Revenue		$13,500,000	$13,500,000
−Op Ex		8,100,000	8,100,000
−New salesperson's salary		75,000	75,000
−Lost cinema EBIT		500,000	500,000
EBITDA		$ 4,825,000	$ 4,825,000
−D&A		1,000,000	1,000,000
EBIT		$ 3,825,000	$ 3,825,000
$\times(1-t)$		0.70	0.70
NOPAT		$ 2,677,500	$ 2,677,500
+D&A		1,000,000	1,000,000
CF Opns		$ 3,677,500	$ 3,677,500
−Cap Exp	$10,000,000	0	0
−Add WC	1,000,000	0	−1,000,000
FCF	−$11,000,000	$ 3,677,500	$ 4,677,500
NPV @ 10%	$11,982,189		

Estimating Cash Flows in Practice

- NOMINAL VERSUS REAL CASH FLOWS
  - **Nominal dollars are what we typically think of. They represent the actual dollar amounts that we expect a project to generate in the future, without any adjustments for purchasing power.**
  - **When prices increase, a given nominal dollar amount will buy less than before.**

Estimating Cash Flows in Practice

- NOMINAL VERSUS REAL CASH FLOWS
  - **Real dollars represent dollars stated in terms of constant purchasing power**
  - **Constant purchasing power is in terms of prices that existed in an earlier period**

    Constant purchasing power: "Last year this cost $50. Today it costs $60."

    The price increased by 20%. In real terms, $60 today has the buying power of $50 a year ago.

Estimating Cash Flows in Practice

- NOMINAL VERSUS REAL CASH FLOWS
  - **The cost of capital, k, can be written as:**

$$1 + k = (1 + \Delta P_e)(1 + r) \qquad (11.3)$$

Where:

k is the nominal cost of capital

ΔPe is the expected rate of inflation

r is the real cost of capital

Estimating Cash Flows in Practice

- NOMINAL VERSUS REAL CASH FLOWS
  - **State all project cash flows as nominal dollars or state all project cash flows as real dollars**

    Value nominal cash flows using a nominal interest rate.

    Value real cash flows using a real interest rate.

Estimating Cash Flows in Practice

- NOMINAL VS. REAL CASH FLOWS EXAMPLE
  - **A doghouse project requires an initial investment of $50,000 and will produce FCFs of $20,000 for four years. At a 15% nominal cost of capital, the NPV of the project is**

$$NPV = -\$50{,}000 + \frac{\$20{,}000}{(1.15)^1} + \frac{\$20{,}000}{(1.15)^2} + \frac{\$20{,}000}{(1.15)^3} + \frac{\$20{,}000}{(1.15)^4}$$

$$= -\$50{,}000 + \$17{,}391.30 + \$15{,}122.87$$

$$+ \$13{,}150.32 + \$11{,}435.06$$

$$= \$7{,}099.55$$

Estimating Cash Flows in Practice

- NOMINAL VS. REAL CASH FLOWS
  - **The real cost of capital for the doghouse project when the expected rate of inflation is 5%**

$$r = \frac{1+k}{1+\Delta P_e} - 1 = \frac{1.15}{1.05} - 1 = 0.09524 \; or \; 9.524\%$$

Estimating Cash Flows in Practice

- NOMINAL VERSUS REAL CASH FLOWS EXAMPLE – CONTINUED
  - **Real cash flows for the doghouse project**

Year 0	Year 1	Year 2	Year 3	Year 4
$-\$50{,}000$	$\frac{\$20{,}000}{1+0.05}$	$\frac{\$20{,}000}{(1+0.05)^2}$	$\frac{\$20{,}000}{(1+0.05)^3}$	$\frac{\$20{,}000}{(1+0.05)^4}$
$= -\$50{,}000$	$= \$19{,}048$	$= \$18{,}141$	$= 17{,}277$	$= \$16{,}454$

Estimating Cash Flows in Practice

- NOMINAL VS REAL CASH FLOWS EXAMPLE
  - **Real NPV for the doghouse project**

$$NPV = -\$50{,}000 + \frac{\$19{,}048}{(1.09524)^1} + \frac{\$18{,}141}{(1.09524)^2} + \frac{\$17{,}277}{(1.09524)^3} + \frac{\$16{,}454}{(1.09524)^4}$$

$$= -\$50{,}000 + \$17{,}391 + \$15{,}123$$

$$+ \$13{,}150 + \$11{,}435$$

$$= \$7{,}099$$

Estimating Cash Flows in Practice

- NOMINAL VS. REAL CASH FLOWS EXAMPLE
  - **NPV for the doghouse project is the same for both calculations**

    It is the same because the nominal rate of 15% includes the adjustment for the 5% expected inflation.

    If the nominal rate was 14% when the expected rate of inflation was 5%, the project would be overvalued.

Estimating Cash Flows in Practice

- TAXES AND DEPRECIATION
  - **The progressive or marginal tax system used in the United States is one in which the proportion of income paid as taxes increases as the amount of taxable income increases**

U.S. Tax Rate Schedule for Single Individual in 2010

EXHIBIT 11.5 **U.S. Tax Rate Schedule for Single Individual in 2010**

The income tax system for individuals in the United States is progressive in that the tax rate increases with income. For very low income levels—say, $20,000 per year—individuals pay only 15 percent on each additional dollar they earn. For individuals who earn more than $373,650, this rate is 35 percent.

Taxable Income		
More Than	But Not More Than	Tax Owed
$0	$8,375	10% of amount beyond $0
$8,375	$34,000	$837.50 + 15% of amount beyond $8,375
$34,000	$82,400	$4,681 + 25% of amount beyond $34,000
$82,400	$171,850	$16,781 + 28% of amount beyond $82,400
$171,850	$373,650	$41,827 + 33% of amount beyond $171,850
$373,650	no limit	$108,421 + 35% of amount beyond $373,650

U.S. Corporate Tax Rate Schedule in 2010

EXHIBIT 11.6 **U.S. Corporate Tax Rate Schedule in 2010**

Just like the tax system for individuals, the tax system for corporations in the United States is progressive, with marginal tax rates ranging from 15 percent to as high as 39 percent.

Taxable Income		
More Than	But Not More Than	Tax Owed
$0	$50,000	15% of amount beyond $0
$50,000	$75,000	$7,500 + 25% of amount beyond $50,000
$75,000	$100,000	$13,750 + 34% of amount beyond $75,000
$100,000	$335,000	$22,250 + 39% of amount beyond $100,000
$335,000	$10,000,000	$113,900 + 34% of amount beyond $335,000
$10,000,000	$15,000,000	$3,400,000 + 35% of amount beyond $10,000,000
$15,000,000	$18,333,333	$5,150,000 + 38% of amount beyond $15,000,000
$18,333,333	———	35% on all income

Estimating Cash Flows in Practice

- TAXES AND DEPRECIATION
  - **One especially important tax difference from a capital budgeting perspective is that the depreciation methods allowed by GAAP do not include some allowed by the IRS**
  - **The straight-line depreciation method illustrated in the performing arts center example is allowed by GAAP and is often used for financial reporting**

Estimating Cash Flows in Practice

- TAXES AND DEPRECIATION
  - **"Accelerated" depreciation under the Modified Accelerated Cost Recovery System (MACRS), has been acceptable for U.S. federal tax calculations since the Tax Reform Act of 1986**
  - **Allows a firm to allocate more of the depreciation expense to the early years of a project, realize larger tax savings sooner, and increase the present value of the tax shield**

MACRS Depreciation Schedules by Allowable Recovery Period

EXHIBIT 11.7 **MACRS Depreciation Schedules by Allowable Recovery Period**

The MACRS schedule lists the tax depreciation rates that firms use for assets placed into service after the Tax Reform Act of 1986 went into effect. The table indicates the percentage of the cost of the asset that can be depreciated in each year during the period that it is being used. Year 1 is the year in which the asset is first placed into service.

Year	3-Year	5-Year	7-Year	10-Year	15-Year	20-Year
1	33.33%	20.00%	14.29%	10.00%	5.00%	3.75%
2	44.45	32.00	24.49	18.00	9.50	7.22
3	14.81	19.20	17.49	14.40	8.55	6.68
4	7.41	11.52	12.49	11.52	7.70	6.18
5		11.52	8.93	9.22	6.93	5.71
6		5.76	8.92	7.37	6.23	5.29
7			8.93	6.55	5.90	4.89
8			4.46	6.55	5.90	4.52
9				6.56	5.91	4.46
10				6.55	5.90	4.46
11				3.28	5.91	4.46
12					5.90	4.46
13					5.91	4.46
14					5.90	4.46
15					5.91	4.46
16					2.95	4.46
17						4.46
18						4.46
19						4.46
20						4.46
21						2.24
Total	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

MACRS Depreciation Calculations for the Performing Arts Center Project

EXHIBIT 11.8 **MACRS Depreciation Calculations for the Performing Arts Center Project ($ thousands)**

Using the percentages from the schedule in Exhibit 11.7, we can calculate the tax (MACRS) depreciation for each year during the life of the performing arts center project.

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Depreciation Calculations										
Beginning book value	$10,000	$9,000	$7,200	$5,760	$4,608	$3,686	$2,949	$2,294	$1,639	$983
MACRS percentage	10.00%	18.00%	14.40%	11.52%	9.22%	7.37%	6.55%	6.55%	6.56%	6.55%
MACRS depreciation	$1,000	$1,800	$1,440	$1,152	$922	$737	$655	$655	$656	$655
Ending book value	$9,000	$7,200	$5,760	$4,608	$3,686	$2,949	$2,294	$1,639	$983	$328

Estimating Cash Flows in Practice

- COMPUTE TERMINAL-YEAR FCF
  - **FCF in the last, or terminal, year of a project often includes cash flows not typically included in the calculations for prior years**
  - **Long-term assets and working capital that are no longer needed to support the project may be sold and funds used in other ways**
  - **Net cash flows from the sale of assets and the impact of the sale on the firm's taxes are included in the terminal-year FCF**

FCF Calculations and NPV

EXHIBIT 11.9 **FCF Calculations and NPV for Performing Arts Center Project with MACRS Depreciation ($ thousands)**

This exhibit shows the FCF calculations and the NPV for the performing arts center project when MACRS is used to compute depreciation. These calculations correspond to those in Exhibit 11.3, which reflect straight-line depreciation. Notice that the NPV is greater with the MACRS system because the tax shields from the depreciation are realized sooner.

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Revenue		$14,100	$14,100	$14,100	$14,100	$14,100	$14,100	$14,100	$14,100	$14,100	$14,100
−Op Ex		8,460	8,460	8,460	8,460	8,460	8,460	8,460	8,460	8,460	8,460
EBITDA		$ 5,640	$ 5,640	$ 5,640	$ 5,640	$ 5,640	$ 5,640	$ 5,640	$ 5,640	$ 5,640	$ 5,640
−D&A		1,000	1,800	1,440	1,152	922	737	655	655	656	655
EBIT		$ 4,640	$ 3,840	$ 4,200	$ 4,488	$ 4,718	$ 4,903	$ 4,985	$ 4,985	$ 4,984	$ 4,985
×(1−t)		0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70
NOPAT		$ 3,248	$ 2,688	$ 2,940	$ 3,142	$ 3,303	$ 3,432	$ 3,490	$ 3,490	$ 3,489	$ 3,490
+D&A		1,000	1,800	1,440	1,152	922	737	655	655	656	655
CF Opns		$ 4,248	$ 4,488	$ 4,380	$ 4,294	$ 4,225	$ 4,169	$ 4,145	$ 4,145	$ 4,145	$ 4,145
−Cap Exp	$10,000	0	0	0	0	0	0	0	0	0	−98
−Add WC	1,000	0	0	0	0	0	0	0	0	0	−1,000
FCF	−$11,000	$ 4,248	$ 4,488	$ 4,380	$ 4,294	$ 4,225	$ 4,169	$ 4,145	$ 4,145	$ 4,145	$ 5,243
NPV @ 10%	$15,610										

FCF Calculations and NPV

EXHIBIT 11.10 **FCF Calculations and NPV for the Performing Arts Center Project with a $1 Million Salvage Value in Year 10 ($ thousands)**

This exhibit shows the FCF calculations and NPV for the performing arts center project assuming that the salvage value of the $10 million capital investment is $1 million in year 10. All other assumptions are the same as in Exhibit 11.9.

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
CF Opns		$4,248	$4,488	$4,380	$4,294	$4,225	$4,169	$4,145	$4,145	$4,145	$4,145
−Cap Exp	$10,000	0	0	0	0	0	0	0	0	0	−798
−Add WC	1,000	0	0	0	0	0	0	0	0	0	−1,000
FCF	−$11,000	$4,248	$4,488	$4,380	$4,294	$4,225	$4,169	$4,145	$4,145	$4,145	$5,943
NPV @ 10%	$15,880										

Estimating Cash Flows in Practice

- EXPECTED CASH FLOWS
  - **It is important to realize that an NPV analysis uses the "expected" FCF for each year of the life of a project**

    Expected means estimated.
  - **Each FCF is a weighted average of the possible cash flows from each possible future outcome**

    The possible cash flow from each outcome is weighted by the probability that the outcome will occur.

Expected FCFs for New Board Game

EXHIBIT 11.11 **Expected FCFs for New Board Game ($ thousands)**

The expected FCF for each year during the life of the board game project equals the weighted average of the possible FCFs in that year.

Outcome	Probability	Year 0	Year 1	Year 2	Year 3
Game is very successful	0.25	−$100	$70	$90	$60
Game sales are acceptable	0.50	−100	50	55	40
Game sales are poor	0.25	−100	25	15	0
Expected FCF		−$100.00	$48.75	$53.75	$35.00

Forecasting Free Cash Flows

- CASH FLOWS FROM OPERATIONS
  - **To forecast incremental cash flows from operations, forecast the incremental net revenue, operating expenses, depreciation, and amortization**

    Analysts often distinguish between types of costs when forecasting operating expenses

    - *fixed costs that do not change with the units of output*
    - *variable costs that change with every unit of output*

Forecasting Free Cash Flows

- INVESTMENT CASH FLOWS
  - **Capital expenditure forecasts reflect the expected level of investment during each year of a project's life, including inflows from salvage value and tax costs or benefits associated with asset sales**

Forecasting Free Cash Flows

- INVESTMENT CASH FLOWS
  - **Four working capital items are included in the cash flow forecasts of an NPV analysis**
    - cash and cash equivalents
    - accounts receivable
    - Inventories
    - accounts payable.

Special Cases

- PROJECTS WITH DIFFERENT LIVES
  - **An efficient method of choosing between mutually exclusive projects with different lives is to compute their equivalent annual cost (EAC**

$$EAC_i = kNPV_i \left\{ \frac{(1+k)^t}{(1+k)^t - 1} \right\} \qquad (11.5)$$

k is the opportunity cost of capital

NPV_i is normal NPV of project I

t is the lifespan of the project.

Special Cases

- PROJECTS WITH DIFFERENT LIVES
  - **Find the EAC of two projects: mower A, which costs $250 and is expected to last two years, and mower B, which costs $360 and is expected to last three years. The cost of capital is 10%.**

$$EAC_A = (0.1)(-\$250)\left\{\frac{(1+0.1)^2}{(1.01)^2 - 1}\right\} = -\$144.05$$

$$EAC_B = (0.1)(-\$360)\left\{\frac{(1+0.1)^3}{(1.01)^3 - 1}\right\} = -\$144.76$$

Special Cases

- WHEN TO HARVEST AN ASSET
  - **Some investments experience a rapid increase in nominal NPV early and later the rate of increase declines. The optimal time to harvest or cash-in these investments is when the rate of increase in an asset's nominal NPV equals the opportunity cost of capital.**

    At this point, liquidate the asset and invest the proceeds in alternatives that yield more than the opportunity cost of capital.

Special Cases

- WHEN TO REPLACE AN EXISTING ASSET
  - **Determining whether to replace an old, but still useful asset with a new one is a common problem**

    Compute the EAC for the new asset and compare it to the annual cash inflows from the old asset. Choose the one with the higher equivalent cash flow.

Special Cases

- THE COST OF USING AN EXISTING ASSET
  - **When calculating incremental after-tax cash flows, include opportunity costs that may not be directly observable**
  - **Sometimes incremental cash flows have to be computed by using the EAC for a given set of cash flows, then adjusting the EAC by the appropriate discount rate and time if the EAC is not in present-value form**