

Annualized Cost

The NPC method is very helpful for comparing projects that have identical lifetimes. What if investments aimed at the same ends have different lifetimes? Suppose that Model A has a five-year lifetime, but Model B has only a four-year lifetime, as follows:

	Model A Refrigerator	Model B Refrigerator
Purchase Price	\$ 105,000	\$ 60,000
Annual Outlay	10,000	20,000
	10,000	20,000
	10,000	20,000
	10,000	20,000
	10,000	20,000
Total Cost	<u>\$ 155,000</u>	<u>\$ 140,000</u>

One approach would be to try to equalize the lifetimes. We could assume that each time a unit wears out it is replaced. If we repeat that process four times for Model A and five times for Model B, at the end of 20 years the two alternatives will have equal lifetimes (see Table 5-2).

We could then proceed to find the NPC for each of these two 20-year alternatives. However, the uncertainties going forward 20 years are substantial. The purchase prices will likely change, as will the annual operating costs. Our needs might change drastically in 10 years, making the acquisitions in the future unnecessary.

As an alternative to the process of equalizing the lifetimes, we can use an approach called the *annualized cost method*. In that approach, one first finds the NPC for each alternative. Then, that cost is translated into a periodic payment for the number of years of the project's lifetime. The project with the lower annualized cost is less expensive on an annual basis in today's dollars.

Consider the refrigerator example. Assume that Model A lasts for five years and Model B lasts for four years. All of the assumptions for Model A are the same as they were originally, so the NPC is still \$142,908, as calculated earlier. Model B is different, because it now has only a four-year life:

Model B:

0	1	2	3	4
↑	10%	↑	↑	↑
PV	\$(20,000)	\$(20,000)	\$(20,000)	\$(20,000)

The Excel spreadsheet formula to find the PV would be:

$$\begin{aligned}
 &= \text{PV}(\text{rate}, \text{nper}, \text{pmt}, \text{fv}, \text{type}) \\
 &= \text{PV}(10\%, 4, -20000) \\
 &= \$63,397
 \end{aligned}$$

To find the NPC, we must also consider the initial acquisition price.

$$\begin{aligned}
 \text{Model B NPC} &= \$60,000 + \$63,397 \\
 &= \$123,397
 \end{aligned}$$

Although the \$123,397 NPC for Model B is lower than the \$142,908 NPC for Model A, we are now comparing apples and oranges. Model B will only last for four years, while Model A will last for five years. We need to account for the fact that we will have to

Table 5-2 Equalizing Asset Lifetimes

Time Period	Action	Model A Refrigerator	Model B Refrigerator
0	Purchase Models A and B	\$105,000	\$ 60,000
1	Annual Outlay	10,000	20,000
2	Annual Outlay	10,000	20,000
3	Annual Outlay	10,000	20,000
4	Annual Outlay	10,000	20,000
4	Purchase Model B		60,000
5	Annual Outlay	10,000	20,000
5	Purchase Model A	105,000	
6	Annual Outlay	10,000	20,000
7	Annual Outlay	10,000	20,000
8	Annual Outlay	10,000	20,000
8	Purchase Model B		60,000
9	Annual Outlay	10,000	20,000
10	Annual Outlay	10,000	20,000
10	Purchase Model A	105,000	
11	Annual Outlay	10,000	20,000
12	Annual Outlay	10,000	20,000
12	Purchase Model B		60,000
13	Annual Outlay	10,000	20,000
14	Annual Outlay	10,000	20,000
15	Annual Outlay	10,000	20,000
15	Purchase Model A	105,000	
16	Annual Outlay	10,000	20,000
16	Purchase Model B		60,000
17	Annual Outlay	10,000	20,000
18	Annual Outlay	10,000	20,000
19	Annual Outlay	10,000	20,000
20	Annual Outlay	10,000	20,000
	Total Outlay	<u>\$620,000</u>	<u>\$700,000</u>

replace it sooner. This is done by treating each NPC as a present value of an annuity and finding the equivalent periodic payment over its lifetime.

Model A:

$$\begin{array}{cccccc}
 0 & & 1 & & 2 & & 3 & & 4 & & 5 \\
 \uparrow & \text{10\%} & \uparrow & & \uparrow & & \uparrow & & \uparrow & & \uparrow \\
 \$ (142,908) & & \text{PMT} & & \text{PMT} & & \text{PMT} & & \text{PMT} & & \text{PMT}
 \end{array}$$

$$= \text{PMT}(\text{rate}, \text{nper}, \text{pv}, \text{fv}, \text{type})$$

$$= \text{PMT}(10\%, 5, -142908)$$

$$= \$37,699$$

Model B:

$$\begin{array}{ccccccccc} & 0 & & 1 & & 2 & & 3 & & 4 \\ & \uparrow & \text{---} 10\% & \uparrow & \text{---} & \uparrow & \text{---} & \uparrow & \text{---} & \uparrow \\ \text{\$}(123,397) & & & \text{PMT} & & \text{PMT} & & \text{PMT} & & \text{PMT} \\ & & & = \text{PMT}(10\%, 4, -123397) & & & & & & \\ & & & = \$38,928 & & & & & & \end{array}$$

Thus, adjusted for their relative lifetimes, including both the acquisition and annual outlays, Model A is less expensive per year than Model B (\$37,699 versus \$38,928).⁶

Net Present Value

The NPC and annualized cost methods discussed previously involve assuming that the capital assets would cost money to acquire. However, it does not assume that the capital asset would have a direct effect on revenues or support. Often, one of the major reasons to acquire a capital asset is to use it to earn more revenues or generate additional financial support. In such cases, we need to consider both the revenues and costs as measured by the present value of their cash inflows and outflows. The *net present value* (NPV) method is one of the most common approaches for making calculations of the present value of inflows and outflows.

The NPV approach calculates the PV of inflows and outflows and compares them. If the PV of the inflows exceeds the PV of the outflows, then the NPV is positive, and the project is considered to be a good investment from a financial perspective:

$$\text{NPV} = \text{PV Inflows} - \text{PV Outflows}$$

and if $NPV > 0$, the project is economically viable.

For example, assume that HQS is contemplating opening a new type of lab. The equipment for the lab will cost \$5 million. Each year there will be costs of running the lab and revenues from the lab. As a result of general financial constraints, the hospital wants to make this investment only if it is financially attractive. The hospital's cost of money is 8 percent. In addition, since the hospital feels that often projected revenues are not achieved by new projects, it wants to build in an extra 2 percent margin for safety. It has decided to do the project only if it earns at least 10 percent.

That 10 percent rate is considered to be a *burdle rate*, or a *required rate of return*. Only if the project can do better than this rate will it be accepted. Therefore, the NPV must be calculated using a 10 percent discount rate. If the project has a positive NPV, that means that it earns more than 10 percent and will be acceptable.

Assume the following projected cash flows from the project:

Proposed New Investment						
(Capital Equipment Has a Four-Year Life)						
	Start	Year 1	Year 2	Year 3	Year 4	Total
Cash In		\$2,700,000	\$2,800,000	\$2,900,000	\$3,000,000	\$11,400,000
Cash Out	\$ 5,000,000	1,000,000	1,300,000	1,400,000	1,600,000	10,300,000
Total	<u>\$(5,000,000)</u>	<u>\$1,700,000</u>	<u>\$1,500,000</u>	<u>\$1,500,000</u>	<u>\$1,400,000</u>	<u>\$ 1,100,000</u>

Although we are just assuming these cash flows, it should be noted that estimating future cash flows is often a difficult task that requires a careful budgeting effort. In total, the

⁶In the case of annuities, an alternative annualization approach would be to find the annuity payment equivalent to the initial outlay and add that amount to the annual payments. That will provide an annualized cost. However, that will work only in cases in which the payments after the initial outlay are an annuity.

- 5-28. The City Transit Authority (CTA) is trying to decide between railcars manufactured by French Corp and Japan Rail Car. The French Corp cars cost more to buy initially, but they are expected to last for 10 years. The Japan Rail Car cars are cheaper initially, but they will wear out in six years. The cash flows related to each of the choices are presented below. If the CTA's cost of capital is 8 percent, which type of car should the CTA buy? Support your answer.

Year	French Corp	Japan Rail Car
0	(\$275,000)	(\$195,000)
1	(10,000)	(15,000)
2	(10,000)	(15,000)
3	(10,000)	(15,000)
4	(10,000)	(15,000)
5	(10,000)	(15,000)
6	(10,000)	(15,000)
7	(10,000)	
8	(10,000)	
9	(10,000)	
10	(10,000)	
Total	<u>(\$375,000)</u>	<u>(\$285,000)</u>

- 5-29. Old Town needs to resurface a section of its roads this spring. The town council is considering using one of two technologies. The first involves putting down stone and gravel the first year and grading the road on an annual basis for the next 10 years. The second involves the application of a road surface called Sure-Pack. Sure-Pack requires maintenance only every five years. Based on experience, the town counselors know the gravel road will last 10 years. The folks in Hiltown, the next town up Route 1, Sure-Packed their roads and expect to get 15 years from them before they will need to be resurfaced again. The cash flows for each alternative are shown in the table below which continues in the next column.

If Old Town's discount rate is 8 percent, which alternative should they choose? Use an annualized cost analysis to support your answer.

Year	Gravel	Sure-Pack
0	\$200,000	\$300,000
1	15,000	
2	15,000	
3	15,000	
4	15,000	
5	15,000	55,000
6	15,000	
7	15,000	
8	15,000	
9	15,000	

Year	Gravel	Sure-Pack
10	15,000	55,000
11		
12		
13		
14		
15		

- 5-30. The town of Millbridge has to make a decision on replacing its garbage truck. It has narrowed the choice down to two different models. Model A will initially cost \$80,000 and then will cost \$4,100 per year to operate for its 20-year life. Model B will initially cost \$100,000 and then will cost \$3,600 per year to operate for its 30-year life. Use the annualized cost approach to determine which is a better choice. Assume a discount rate of 6 percent per year.

- 5-31. Smith Good Deeds Society is considering a four-year investment opportunity with the following cash flows:

Year	Cash In	Cash Out
0	0	650
1	140	25
2	140	25
3	140	25
4	340	25

If Smith uses an annual discount rate of 8 percent, should it pursue the investment? Show calculations to support your answer.

- 5-32. Duncombe Village Golf Course is considering the purchase of new equipment that will cost \$1,250,000 if purchased today and will generate the following cash disbursements and receipts. Should Duncombe pursue the investment if the cost of capital is 8 percent? Why?

Year	Cash Receipts	Cash Disbursements	Net Cash Flow
1	950,000	500,000	450,000
2	925,000	475,000	450,000
3	800,000	450,000	350,000
4	675,000	430,000	245,000

- 5-33. The town of Millbridge has just agreed to pay a pension to the town clerk. The pension will be \$40,000 per year for the next 20 years. Dwight Ives, the town manager, has decided that the town should put aside enough money today to pay for the entire pension. He has argued that the town will not receive the clerk's services in the future, so future taxpayers should not have to pay the pension. How much must be put aside,

assuming the town earns 6 percent compounded annually? Does this funding approach make sense to you?

- 5-34. Suppose that you were to receive a \$30,000 gift upon graduation from your master's degree program, when you turn 31 years old. At the end of each working year for 34 years, you put an additional \$5,000 into an IRA.
- Assuming you earn an annual compounded rate of 7.5 percent on the gift and the IRA investments, how much would be available when you retire at age 65 years?
 - If you hope to draw money out of that investment at the end of every month for 30 years following retirement, how much could you withdraw each month? Assume that during the years you are retired, the money earns an annual rate of 6 percent compounded monthly.
 - You realize that if you draw out that amount each month there will be nothing left for your two children. You decide that you want to leave \$250,000 to each of your children 30 years after you retire. How much would you have to invest at your retirement to fund your children's inheritance? Assume that you will earn 7.5 percent compounded annually on the money invested for your children.
 - If you set aside the money for your children, how much could you draw out each month during your retirement if you can earn 6 percent per annum compounded monthly on the portion that is not set aside for the children?
- 5-35. The Old School is trying to decide whether they should purchase or lease a new high-speed photocopier machine. It will cost the school \$14,000 to purchase the copier and \$750 each year to maintain the machine over the course of its six-year useful life. At the end of the sixth year, Old School expects to be able to sell the copier for \$1,000. A dealer has offered to lease the school the same copier for a payment of \$750 at the beginning of the lease plus lease payments of \$3,450 per year for four years. Lease payments include all maintenance. The dealer was unable to offer a lease longer than four years. Lease payments would be made at the end of each year. If the Old School's discount rate is 8 percent, which alternative should it choose and why?
- 5-36. Rural Consolidated Fire Services (RCFS) is considering applying for a Federal Department of Energy (DOE) grant that would allow it to install solar panels on

each of its four firehouses. The roofs on each of the firehouses are big enough to accommodate 30,000 square feet of panels. Panels cost \$8 per square foot. In addition, RCFS will have to pay \$8,000 per firehouse for batteries and other equipment costs and \$10,000 per firehouse for installation. RCFS expects the solar panels on the four buildings to generate a total of \$6,000 worth of electricity each month for the next 10 years. If RCFS puts panels on all four firehouses, the DOE will give RCFS \$500,000 toward the cost of buying and installing the solar-power system. Federal stimulus money will be received at the start of the project. If RCFS's discount rate is 6 percent, should RCFS install the panels based solely on financial considerations? Support your answer with the appropriate TVM calculations.

- 5-37. The Town Pool is considering investing \$3,200 today in a popcorn maker. The annual cash profits from the machine will be \$500 for each of the 10 years of its useful life. What is the IRR on the investment?
- 5-38. Urban Housing Agency (UHA) is considering contracts with private developers to provide low-income housing at various locations in the city. The startup costs to UHA for each location are \$115,000, all of which must be paid to the developers in cash at the beginning. The housing rents would provide UHA net cash flows of \$3,000 per month for the first 12 months, \$4,000 per month for the following 12 months, and \$5,000 for the remaining 12 months of a three-year contract. Urban only invests in projects that earn an annual rate of return of at least 12 percent. What rate of return would Urban earn on the contracts? Should Urban accept the contract? Why? Do not solve this problem using a financial calculator.
- 5-39. Refer to Problem 2-28 at the end of Chapter 2. Assume that the capital acquisitions in that problem were made at the beginning of fiscal year 2012. It is now the end of fiscal year 2014. Prepare a schedule showing those capital assets, their cost, their useful life, the accumulated depreciation at the beginning of 2014, the depreciation expense charged for 2014 (assuming straight-line depreciation and no salvage value), the accumulated depreciation as of the end of the year, and the net book value (cost less accumulated depreciation) as of the end of 2014. Use a spreadsheet program such as Excel. As River Country may dispose of the items at different times, note that it is necessary to track each item separately.

Suggested Readings

Anthony, Robert N., and Leslie Pearlman Breitner. *Essentials of Accounting*, 10th ed. Upper Saddle River, N.J.: Prentice Hall, 2010.

Bierman, Harold, and Seymour Smidt. *The Capital Budgeting Decision: Economic Analysis of Investment Projects*, 8th ed. Upper Saddle River, N.J.: Prentice Hall, 1993.