Making Investment Decisions with the Net Present Value Rule

Applying the Net Present Value Rule

Four general rules:

1. Only *cash flow* is relevant.
2. Always estimate cash flows on an *incremental basis*.
3. Be consistent in your treatment of *inflation*.
4. *Separate* investment and financing decisions.

Rule 1: Only Cash Flow Is Relevant

Net present value depends on future cash flow. Cash flow is simply the difference between cash received and cash paid out.

Cash flow = cash received - cash paid out ≠ accounting income

Accounting income is intended to show how well the company is performing. Therefore, accountants *start* with **“dollars in”** and **“dollars out”**.

Capital Expenses

When calculating expenditures, the accountant deducts *current* expenses but does not deduct *capital* expenses.

→ Instead of deducting capital expenditure as it occurs, the accountant *depreciates* the outlay over several years

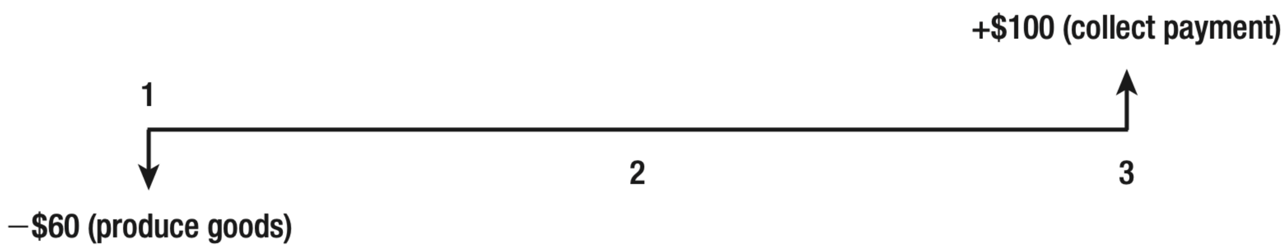
When calculating NPV, **state capital expenditures when they occur**, not later when they show up as depreciation. To go from accounting income to cash flow, you need to add back depreciation (which is not a cash outflow) and subtract capital expenditure (which is a cash outflow).

Working Capital

When measuring income, accountants try to show profit as it is *earned,* rather than when the company and its customers get around to paying their bills.

EXAMPLE

Consider a company that spends $60 to produce goods **in period 1**. It sells these goods **in period 2** for $100, but its customers do not pay their bills until **period 3**. The following diagram shows the firm's cash flows. In period 1 there is a cash *outflow* of $60. Then, when customers pay their bills in period 3, there is an *inflow* of $100.



In period 2, when the goods are taken out of inventory and sold, the accountant shows a $60 *reduction* in inventories, and record accounts receivable of $100 to show that the company's customers owe $100 in unpaid bills.

Accounts look like:

Revenue	$100
Less cost of goods sold	– 60
Income	$ 40

(Period 2)

To go from the figure for income to the actual cash flows, you need to add back these changes in inventories and receivables:

	Period		
	1	2	3
Accounting income	0	+40	0
– Investment in inventories	–60	+60	0
– Investment in receivables	0	–100	+100
= Cash paid out	–60	0	+100

Net working capital (often referred to simply as *working capital*) is the difference between a company's **short-term** assets and liabilities.

- **Net working capital = accounts receivable + inventory – accounts payable**

- **Cash flows = change in net working capital = current asset - current liability = profit *(after tax)* - change in inventory**

  = net working capital of the *last* year - net working capital of the *current* year

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Working capital is a common source of confusion in capital investment calculations. Here are **the most common mistakes:**

1. *Forgetting about working capital entirely.*
2. *Forgetting that working capital may change during the life of the project.*

   Imagine that you sell $100,000 of goods a year and customers pay on average six months late. You therefore have $50,000 of unpaid bills. Now you increase prices by 10%, so revenues increase to $110,000. If customers continue to pay six months late, unpaid bills increase to $55,000, and so you need to make an *additional* investment in working capital of $5,000.
3. *Forgetting that working capital is recovered at the end of the project.*

   When the project comes to an end, inventories are run down, any unpaid bills are (you hope) paid off, and you recover your investment in working capital. This generates a cash *inflow.*

Rule 2: Estimate Cash Flows on an Incremental Basis

The value of a project depends on *all* the additional cash flows that follow from project acceptance.

Remember to Include Taxes

Taxes are an **expense** just like wages and raw materials. Therefore, cash flows should be estimated on an **after-tax basis**.

Some firms do not deduct tax payments. They try to offset this mistake by discounting the cash flows at a rate that is higher than the cost of capital. Unfortunately, there is *no reliable formula* for making such adjustments to the discount rate.

Do Not Confuse Average with Incremental Payoffs

A situation: the *incremental* NPV from investing in a loser is strongly positive

→ A division with an **outstanding past profitability record** may have **run out of good opportunities**.

e.g. You would not pay a large sum for a 20-year-old horse, sentiment aside, regardless of how many races that horse had won or how many champions it had sired.

Include All Incidental Effects

It is important to consider a project's **effects on the remainder** of the firm's business. This incidental effect needs to be factored into the incremental cash flows.

Sometimes a new project will *help* the firm's existing business.

Forecast Sales Today and Recognize After-Sales Cash Flows to Come Later

Financial managers should forecast **all incremental cash flows** generated by an investment. Sometimes these incremental cash flows last for decades.

Many manufacturing companies depend on the revenues that come *after* their products are sold, like services and parts.

Include Opportunity Costs

The cost of a resource may be relevant to the investment decision even when no cash changes hands, that is an opportunity cost.

The proper comparison is "with or without."

e.g.

With	Take Project	After	Cash Flow, with Project
Firm owns land	→	Firm still owns land	0

Without	Do Not Take Project	After	Cash Flow, without Project
	→	Firm sells land for $100,000	$100,000

Comparing the two possible "afters," we see that the firm gives up $100,000 by undertaking the project.

Sometimes opportunity costs may be very difficult to estimate; however, where the resource **can be freely traded**, its **opportunity cost is simply equal to the market price**.

Forget Sunk Costs

Sunk costs are past and irreversible outflows.

Because sunk costs are bygones, they cannot be affected by the decision to accept or reject the project, and so they should be **ignored**.

The *sunk-cost fallacy*: Fail in recognizing that the money that had already been spent was irrecoverable and, therefore, <u>irrelevant to the decision to terminate the project</u>.

Beware of Allocated Overhead Costs

Overheads include such items as supervisory salaries, rent, heat, and light. <u>These overheads may not be related to any particular project, but they have to be paid for somehow.</u>

In investment appraisal we should include **only** the *extra* expenses that would **result from the project**.

A project **may** generate extra overhead expenses; then again, it **may not**. We should be cautious about assuming that the accountant's allocation of overheads represents the true extra expenses that would be incurred.

e.g.

New products need to be painted. This can be done using excess capacity of the painting machine, which currently runs at a cost of $50,000 regardless of how much it is used.

Remember Salvage Value

When the project comes to an end, you may be able to *sell* the plant and equipment or *redeploy* the assets elsewhere in the business.

If the equipment is sold, you must pay tax on **the *difference* between the sale price and the book value** of the asset. The salvage value ***(net of any taxes)*** represents a positive cash flow to the firm.

Some projects have **significant shut-down costs**, in which case the final cash flows may be *negative.*

Rule 3: Treat Inflation Consistently

Interest rates are usually quoted in ***nominal*** rather than *real* terms.

If the discount rate is stated in nominal terms, then consistency requires that cash flows should **also be estimated in nominal terms**, taking account of trends in selling price, labor and materials costs, etc.

→ This calls for more than simply applying *a single assumed inflation rate* to all components of cash flow. *(Like labor costs increase faster than inflation and tax savings from depreciation stay constant in norminal terms, not changing with inflation.)*

How to use nominal discount rate to discount real cash flows?

- restate the cash flows in nominal terms and discount at nominal discount rate
- restate the discount rate in real terms and use it to discount the real cash flows

Convert the nominal discount rate into real terms:

$$Real\ discount\ rate = \frac{1 + nominal\ discount\ rate}{1 + inflation\ rate} - 1$$

Summary

- Discount **nominal** cash flows at a **nominal** discount rate.
- Discount **real** cash flows at a **real** rate.

Never mix real cash flows with nominal discount rates or nominal flows with real rates.

Rule 4: Separate Investment and Financing Decisions

Suppose you finance a project **partly with debt**.

How should you treat the proceeds from the debt issue and the interest and principal payments on the debt?

→ You should *neither* subtract the debt proceeds from the required investment *nor* recognize the interest and principal payments on the debt as cash outflows.

→ View the project **as if it were all-equity-financed**, treating **all cash outflows required for the project as coming from stockholders and all cash inflows as going to them**.

This procedure focuses **exclusively** on the *project* cash flows, **not** the cash flows associated with *alternative financing schemes*.

To separate the analysis of the investment decision from that of the financing decision:

1. ask whether the project has a positive net present value, assuming all-equity financing
2. if the project is viable, undertake a separate analysis of the best financing strategy

Example—IM&C's Fertilizer Project

EXAMPLE

		Period							
		0	1	2	3	4	5	6	7
1	Capital investment	10,000							–1,949[a]
2	Accumulated depreciation		1,583	3,167	4,750	6,333	7,917	9,500	0
3	Year-end book value	10,000	8,417	6,833	5,250	3,667	2,083	500	0
4	Working capital		550	1,289	3,261	4,890	3,583	2,002	0
5	Total book value (3 + 4)		8,967	8,122	8,511	8,557	5,666	2,502	0
6	Sales		523	12,887	32,610	48,901	35,834	19,717	
7	Cost of goods sold[b]		837	7,729	19,552	29,345	21,492	11,830	
8	Other costs[c]	4,000	2,200	1,210	1,331	1,464	1,611	1,772	
9	Depreciation		1,583	1,583	1,583	1,583	1,583	1,583	0
10	Pretax profit (6 – 7 – 8 – 9)	–4,000	–4,097	2,365	10,144	16,509	11,148	4,532	1,449[d]
11	Tax at 35%	–1,400	–1,434	828	3,550	5,778	3,902	1,586	507
12	Profit after tax (10 – 11)	–2,600	–2,663	1,537	6,593	10,731	7,246	2,946	942

TABLE 6.1 **IM&C's guano project—projections ($ thousands) reflecting inflation and assuming straight-line depreciation.**

[a] Salvage value.
[b] We have departed from the usual income-statement format by *not* including depreciation in cost of goods sold. Instead, we break out depreciation separately (see line 9).
[c] Start-up costs in years 0 and 1, and general and administrative costs in years 1 to 6.
[d] The difference between the salvage value and the ending book value of $500 is a taxable profit.

- **Line 1: capital investment**

The project requires **an investment of $10 million** in plant and machinery (line 1). This machinery can be dismantled and sold for net proceeds estimated at $1.949 million in year 7 (line 1, column 7). This amount is your forecast of the plant's *salvage value.*

- **Line 2: depreciation**

Whoever prepared Table 6.1 depreciated the capital investment over six years to an arbitrary **salvage value of $500,000**, which is less than your forecast of salvage value. *Straight-line depreciation* was assumed.

$$Depreciation\ in\ year\ t = \frac{1}{T} \times depreciable\ amount = \frac{1}{6} \times (10 - 0.5) = \frac{1}{6} \times 9.5 = \$1.583\ million$$

- **Lines 6 through 12**

a simplified income statement for the guano project

All the entries in the table are *nominal amounts*.

		Period							
		0	1	2	3	4	5	6	7
1	Capital investment and disposal	–10,000	0	0	0	0	0	0	1,442[a]
2	Change in working capital		–550	–739	–1,972	–1,629	1,307	1,581	2,002
3	Sales	0	523	12,887	32,610	48,901	35,834	19,717	0
4	Cost of goods sold	0	837	7,729	19,552	29,345	21,492	11,830	0
5	Other costs	4,000	2,200	1,210	1,331	1,464	1,611	1,772	0
6	Tax on income	–1,400	–1,434	828	3,550	5,778	3,902	1,586	
7	Operating cash flow (3 – 4 – 5 – 6)	–2,600	–1,080	3,120	8,177	12,314	8,829	4,529	
8	Net cash flow (1 + 2 + 7)	–12,600	–1,630	2,381	6,205	10,685	10,136	6,110	3,444
9	Present value at 20%	–12,600	–1,358	1,654	3,591	5,153	4,074	2,046	961
10	Net present value =	+3,520	(sum of 9)						

TABLE 6.2 **IM&C's guano project—initial cash-flow analysis assuming straight-line depreciation ($ thousands).**

[a] Salvage value of $1,949 less tax of $507 on the difference between salvage value and ending book value.

Table 6.2 derives cash-flow forecasts from the investment and income data given in Table 6.1.

The project's net cash flow is the sum of three elements:

Net cash flow =

cash flow from capital investment and disposal + cash flow from changes in working capital + operating cash flow

- **Row 1** shows the initial capital investment and the estimated salvage value of the equipment when the project comes to an end. **If, as you expect, the salvage value is higher than the depreciated value of the machinery, you will have to pay tax on the difference.** So the salvage value in row 1 is shown **after payment of this tax**.
- **Row 2** of the table shows the changes in working capital.

- **The remaining rows** calculate the project's operating cash flows. In calculating the operating cash flows we **did not deduct depreciation**.

  The operating cash flow is simply t*he dollars coming in less the dollars going out*:

  Operating cash flow = revenues − cash expenses − taxes initial investment

actual salvage value (sale price)

		Period							
		0	1	2	3	4	5	6	7
1	Capital investment	10,000							–1,949[a]
2	Accumulated depreciation		1,583	3,167	4,750	6,333	7,917	9,500	0
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estimated salvage value

diff in salvage value ⇓ taxable part 1,949−500

$\frac{1}{6}\times(10{,}000-500)$

1,449×35%

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pretax profit ×35%

working capital (yr 1) − working capital (yr 0) = 0 − 550 = −550

1,949 − 507 ⇒ tax deducted

		Period							
		0	1	2	3	4	5	6	7
1	Capital investment and disposal ①	–10,000	0	0	0	0	0	0	1,442[a]
2	Change in working capital ②		–550	–739	–1,972	–1,629	1,307	1,581	2,002
3	Sales	0	523	12,887	32,610	48,901	35,834	19,717	0
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8	Net cash flow (1 + 2 + 7)	–12,600	–1,630	2,381	6,205	10,685	10,136	6,110	3,444
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Investments in Working Capital

Working capital summarizes the net investment in short-term assets associated with a firm, business, or project.

Its **most important components** are *inventory, accounts receivable,* and *accounts payable.*

Why does working capital increase?

1. Sales recorded on the income statement overstate actual cash receipts because sales are increasing and customers are slow to pay their bills. Therefore, *accounts receivable increase*.
2. It takes several months for processed guano to age properly. Thus, as projected sales increase, *larger inventories have to be held in the aging sheds*.
3. An offsetting effect occurs if payments for materials and services used in guano production are delayed. In this case *accounts payable will increase*.

How to calculate working capital?

1. Working capital = inventory + accounts receivable – accounts payable
2. estimate cash flow directly by counting the dollars coming in from customers and deducting the dollars going out to suppliers

TABLE 6.3
Details of cash-flow forecast for IM&C's guano project in year 3 ($ thousands).

Cash Flows		Data from Forecasted Income Statement		Working-Capital Changes
Cash inflow	=	Sales	–	Increase in accounts receivable
$31,110	=	32,610	–	1,500
Cash outflow	=	Cost of goods sold, other costs, and taxes	+	Increase in inventory net of increase in accounts payable
$24,905	=	(19,552 + 1,331 + 3,550)	+	(972 – 500)

Net cash flow = cash inflow – cash outflow
$6,205 = 31,110 – 24,905

- *If you replace each year's sales with that year's cash payments received from customers, you don't have to worry about accounts receivable.*
- *If you replace cost of goods sold with cash payments for labor, materials, and other costs of production, you don't have to keep track of inventory or accounts payable.*

A Further Note on Depreciation

Depreciation is a noncash expense; it is important only because i**t reduces taxable income**. It provides an annual *tax shield* equal to the product of depreciation and the marginal tax rate:

Tax shield = depreciation × tax rate

Accelerated depreciation

The current rules for tax depreciation in the United States were set by the Tax Reform Act of 1986, which established a Modified Accelerated Cost Recovery System **(MACRS)**.

The tax depreciation schedules:

	Tax Depreciation Schedules by Recovery-Period Class						
	Year(s)	3-year	5-year	7-year	10-year	15-year	20-year
1	1	33.33	20.00	14.29	10.00	5.00	3.75
2	2	44.45	32.00	24.49	18.00	9.50	7.22
3	3	14.81	19.20	17.49	14.40	8.55	6.68
4	4	7.41	11.52	12.49	11.52	7.70	6.18
5	5		11.52	8.93	9.22	6.93	5.71
6	6		5.76	8.92	7.37	6.23	5.28
7	7			8.93	6.55	5.90	4.89
8	8			4.46	6.55	5.90	4.52
9	9				6.56	5.91	4.46
10	10				6.55	5.90	4.46
11	11				3.28	5.91	4.46
12	12					5.90	4.46
13	13					5.91	4.46
14	14					5.90	4.46
15	15					5.91	4.46
16	16					2.95	4.46
17	17-20						4.46
18	21						2.23

TABLE 6.4 Tax depreciation allowed under the modified accelerated cost recovery system (MACRS) (figures in percent of depreciable investment).

Notes:
1. Tax depreciation is lower in the first and last years because assets are assumed to be in service for only six months.
2. Real property is depreciated straight-line over 27.5 years for residential property and 39 years for nonresidential property.

Calculate tax shield using MACRS:

Tax depreciation = MACRS percentage × depreciable investment

Tax shield = tax depreciation × tax rate

Using the NPV Rule to Choose among Projects

- **The investment timing problem.** Should you invest now or wait and think about it again next year?

  (Here, today's investment is competing with possible future investments.)

- **The choice between long- and short-lived equipment.** Should the company save money today by installing cheaper machinery that will not last as long?

  (Here, today's decision would accelerate a later investment in machine replacement.)

- **The replacement problem.** When should existing machinery be replaced?

  (Using it another year could delay investment in more modern equipment.)

- **The cost of excess capacity.** What is the cost of using equipment that is temporarily not needed?

  (Increasing use of the equipment may bring forward the date at which additional capacity is required.)

Problem 1: The Investment Timing Decision

The fact that a project has a positive NPV does not mean that it is best undertaken now. It might be even more valuable if undertaken in the future.

How to find optimal timing?

1. Examine alternative start dates (t) for the investment and calculate the net *future* value at each of these dates
2. To find which of the alternatives would **add most** to the firm's *current* value after discounting these net future values back to the present:

$$Net\ present\ value\ of\ investment\ if\ undertaken\ at\ date\ t = \frac{net\ future\ value\ at\ date\ t}{(1+r)^t}$$

EXAMPLE

Suppose you own a large tract of inaccessible timber.

The longer you wait, the higher the investment required. On the other hand, lumber prices may rise as you wait, and the trees will keep growing, although at a gradually decreasing rate.

Suppose that the net present value of the harvest at different *future* dates is as follows:

	Year of Harvest					
	0	1	2	3	4	5
Net *future* value ($ thousands)	50	64.4	77.5	89.4	100	109.4
Change in value from previous year (%)		+28.8	+20.3	+15.4	+11.9	+9.4

Suppose the appropriate discount rate is 10%.

The net present value for other harvest dates is as follows:

	Year of Harvest					
	0	1	2	3	4	5
Net present value ($ thousands)	50	58.5	64.0	67.2	68.3	67.9

The optimal point to harvest the timber is **year 4** because this is the point that **maximizes NPV**.

Problem 2: The Choice between Long- and Short-Lived Equipment

Equivalent annual cash flow: The cash flow per period with the same present value as the actual cash flow as the project.

$$\textit{Equivalent annual cash flow} = \frac{\textit{present value of cash flows}}{\textit{annuity factor}}$$

EXAMPLE

Suppose the firm is forced to choose between two machines, A and B. The two machines are designed differently but have *identical capacity* and do *exactly the same job*.

- Machine A costs **$15,000** and will last **three years**. It costs **$5,000 per year to run**.
- Machine B costs only **$10,000**, but it will last only **two years** and costs **$6,000 per year to run**.

Because the two machines produce exactly the same product, the only way to choose between them is on the basis of cost. The present value of each machine's cost is as follows:

Costs ($ thousands)					
Year:	0	1	2	3	PV at 6% ($ thousands)
Machine A	15	5	5	5	$28.37
Machine B	10	6	6	—	21.00

Choose the one with *lower annual cost*.

→ To calculate the *equivalent annual cost*.

- For machine A:

Costs ($ thousands)					
Year:	0	1	2	3	PV at 6% ($ thousands)
Machine A	15	5	5	5	28.37
Equivalent annual cost		10.61	10.61	10.61	28.37

PV of annuity = PV of A's costs = 28.37 = **annuity payment × 3-year annuity factor**

At a 6% cost of capital, the annuity factor is 2.673 for three years, so:

Annuity payment = 28.37 / 2.673 = 10.61

- For machine B:

Costs ($ thousands)				
Year:	0	1	2	PV at 6% ($ thousands)
Machine B	10	6	6	21.00
Equivalent annual cost		11.45	11.45	21.00

→ Machine A is better, because *its equivalent annual cost is less* ($10,610 versus $11,450 for machine B).

Problem 3: When to Replace an Old Machine

EXAMPLE

You are operating an elderly machine that is expected to produce a net cash *inflow* of $4,000 in the coming year and $4,000 next year. After that it will give up the ghost. You can replace it now with a new machine, which costs $15,000 but is much more efficient and will provide a cash inflow of $8,000 a year for three years.

You want to know whether you should replace your equipment now or wait a year.

We can calculate **the NPV of the new machine** and also **its equivalent annual cash flow**, that is, the three-year annuity that has the same net present value:

Cash Flows ($ thousands)					
	C_0	C_1	C_2	C_3	NPV at 6% ($ thousands)
New machine	–15	+8	+8	+8	6.38
Equivalent annual cash flow		+2.387	+2.387	+2.387	6.38

→ The cash flows of the new machine are equivalent to an annuity of $2,387 per year, which is less than the $4,000 generated by the old machine per year.

→ Shouldn't replace.

Problem 4: Cost of Excess Capacity

EXAMPLE

A manufacturer operates two machines, each of which has a capacity of 1000 units a year. They have an **infinite life** and no savage value. Their only costs are the operating expenses of $2 per unit.

It is known that the the company operates a seasonal business:

- During the fall and winter, when the demand is high, each machine produces at capacity.

- During the spring and summer, each machine works at 50% of capacity.

*If the discount rate is 10%, and the machines are **kept indefinitely**, what is the present value of the operating cost?*

Now the company is considering whether to replace these machines with the new equipment. The new machines have the same capacity and last indefinitely. Each new machine costs $6,000 with operating expenses being only $1 per unit. *Should the company buy new machines?*

3 plans:

1. **2 old machines**

Item	Account
Annual output per machine	750 units
Operating cost per machine	750 units × $2 per unit = $1,500
PV of operating cost per machine	$1,500 / 0.1 = $15,000
PV of operating cost of two machine	2 × $15,000 = $30,000

2. **2 new machines**

Item	Account
Annual output per machine	750 units
Operating cost per machine	750 units × $1 per unit = $750
PV of operating cost per machine	$6,000 + $750 / 0.1 = $13,500
PV of operating cost of two machine	2 × $13,500 = $27,000

3. **1 old machine + 1 new machine**

Item	1 old machine	1 new machine
Annual output per machine	500 units	1,000 units
Operating cost per machine	500 units × $2 per unit = $1,000	1,000 units × $1 per unit = $1,000
PV of operating cost per machine	$1,000 / 0.1 = $10,000	$6,000 + $1,000 / 0.1 = $16,000
PV of operating cost of two machine	*$10,000 + $16,000 = $26,000*	

So the best plan is to replace ine of the old machines with a new machine.

Appendix

Cash Flow Calculations Based on Financial Reports

Free cash flow = (net profit + depreciation) - change in working capital - capital expenditure

- Profit sheet: net profit, depreciation
- Balance sheet: change in working capital

Net profit + depreciation = (1 - T) × operating profit + T × depreciation

→ T × depreciation: depreciation tax shield

→ T: the "effective" tax rate

→ **Operating profit = operating revenues - operating expenses**

→ **Net Profit = (1 - T) × (operating profit - depreciation)**

Summary

Chapter 6

By now present value calculations should be a matter of routine. However, forecasting project cash flows will never be routine. Here is a checklist that will help you to avoid mistakes:

1. **Discount cash flows, not profits.**
    1. Remember that <u>depreciation is not a cash flow</u> (though it may *affect tax payments*).
    2. Concentrate on <u>cash flows after taxes</u>. Stay alert for differences between tax depreciation and depreciation used in reports to shareholders.
    3. Remember the investment in <u>working capital</u>. As sales increase, the firm may need to make additional investments in working capital, and as the project comes to an end, it will recover those investments.
    4. Beware of <u>allocated overhead charges for heat, light, and so on</u>. These may not reflect the incremental costs of the project.
2. Estimate the project's *incremental* cash flows—that is, **the difference between the cash flows with the project and those without the project**.
    1. <u>Include all indirect effects of the project</u>, such as its impact on the sales of the firm's other products.
    2. <u>Forget sunk costs.</u>

    3. Include *opportunity costs*, such as the value of land that you would otherwise sell.
3. **Treat inflation consistently.**
    1. If cash flows are forecasted in nominal terms, use a nominal discount rate.
    2. Discount real cash flows at a real rate.

When we assessed the guano project, we transformed the series of future cash flows into a single measure of their present value. Sometimes it is useful to reverse this calculation and to convert the present value into a stream of annual cash flows. For example, when choosing between two machines with unequal lives, you need to compare equivalent annual cash flows.