MAKING INVESTMENT DECISIONS WITH THE NET PRESENT VALUE RULE

Topics Covered

- Applying the Net Present Value Rule
- Example - IM&C Fertilizer Project
- Using the NPV Rule to Choose among Projects
  - The Investment Timing Problem
  - The Choice between Long- and Short-Lived Equipment
  - When to Replace an Old Machine

Applying NPV Rule

<u>Rule 1: Only Cash Flow Is Relevant</u>

- Capital Expenses
  - Record capital expenditures when they occur
  - To determine cash flow from income, add back depreciation and subtract capital expenditure
- Working Capital
  - Difference between company's short-term assets and liabilities

Remember that only cash flows are relevant. Use incremental, after-tax cash flows to calculate NPVs. Remind students to be very careful when using accounting data.

What To Discount

Points to Watch Out For

Rule 2: Estimate Cash Flows on an Incremental Basis

- Remember to include taxes
- Do not confuse average with incremental payoffs
- Include all incidental effects
- Forecast sales today and recognise after-sales cash flows to come later
- Include opportunity costs
- Forget sunk costs
- Beware of allocated overhead costs
- Remember salvage value

Inflation

<u>Rule 3 - Treat Inflation Consistently</u>

- Be consistent in how you handle inflation!!
- Use nominal interest rates to discount nominal cash flows
- Use real interest rates to discount real cash flows
- You will get the same results, whether you use nominal or real figures

Inflation

Example

You invest in a project that will produce real cash flows of -$100 in year zero and then $35, $50, and $30 in the three respective years. If the nominal discount rate is 15% and the inflation rate is 10%, what is the NPV of the project?

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

Inflation

Example - Nominal figures

Year	Cash Flow	PV @ 15%
0	-100	-100
1	$35 \times 1.10 = 38.5$	$\frac{38.5}{1.15} = 33.48$
2	$50 \times 1.10^2 = 60.5$	$\frac{60.5}{1.15^2} = 45.75$
3	$30 \times 1.10^3 = 39.9$	$\frac{39.9}{1.15^3} = 26.23$
		\$5.5

Inflation

Example - continued

You invest in a project that will produce real cash flows of -$100 in year zero and then $35, $50, and $30 in the three respective years. If the nominal discount rate is 15% and the inflation rate is 10%, what is the NPV of the project?

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

$$= \frac{1.15}{1.10} - 1 = .045$$

Inflation

Example - Real figures

Year	Cash Flow	PV@4.50%
0	-100	-100
1	35	$\frac{35}{1.045} = -33.49$
2	50	$\frac{50}{1.045^2} = 45.79$
3	30	$\frac{30}{1.045^3} = 26.29$
		$= \$5.5$

Rule 4: Separate Investment and Financing Decision

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

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

IM&C's Guano Project

Revised projections ($1000s) reflecting inflation

		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

IM&C's Guano Project

- NPV using nominal cash flows

$$\text{NPV} = -12{,}000 - \frac{1{,}630}{1.20} + \frac{2{,}381}{(1.20)^2} + \frac{6{,}205}{(1.20)^3} + \frac{10{,}685}{(1.20)^4} + \frac{10{,}136}{(1.20)^5}$$

$$+ \frac{6{,}110}{(1.20)^6} + \frac{3{,}444}{(1.20)^7} = 3{,}520 \text{ or } \$3{,}520{,}000$$

IM&C's Guano Project

Cash flow analysis ($1000s)

		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)						

IM&C's Guano Project

Details of cash flow forecast in year 3 ($1000s)

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				

IM&C's Guano Project

Tax depreciation allowed under the modified accelerated cost recovery system (MACRS)

(Figures in percent of depreciable investment)

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

IM&C's Guano Project

Tax Payments ($1000s)

		Period							
		0	1	2	3	4	5	6	7
1	Sales[a]		523	12,887	32,610	48,901	35,834	19,717	
2	Cost of goods sold[a]		837	7,729	19,552	29,345	21,492	11,830	
3	Other costs[a]	4,000	2,200	1,210	1,331	1,464	1,611	1,772	
4	Tax depreciation		2,000	3,200	1,920	1,152	1,152	576	
5	Pretax profit (1 – 2 – 3 – 4)	–4,000	–4,514	748	9,807	16,940	11,579	5,539	1,949[b]
6	Tax at 35%[c]	–1,400	–1,580	262	3,432	5,929	4,053	1,939	682

IM&C's Guano Project

Revised cash flow analysis ($1000s)

		Period							
		0	1	2	3	4	5	6	7
1	Capital investment and disposal	–10,000	0	0	0	0	0	0	1,949
2	Change in working capital		–550	–739	–1,972	–1,629	1,307	1,581	2,002
3	Sales[a]	0	523	12,887	32,610	48,901	35,834	19,717	0
4	Cost of goods sold[a]	0	837	7,729	19,552	29,345	21,492	11,830	0
5	Other costs[a]	4,000	2,200	1,210	1,331	1,464	1,611	1,772	0
6	Tax[b]	–1,400	–1,580	262	3,432	5,929	4,053	1,939	682
7	Operating cash flow (3 – 4 – 5 – 6)	–2,600	–934	3,686	8,295	12,163	8,678	4,176	–682
8	Net cash flow (1 + 2 + 7)	–12,600	–1,484	2,947	6,323	10,534	9,985	5,757	3,269
9	Present value at 20%	–12,600	–1,237	2,047	3,659	5,080	4,013	1,928	912
10	Net present value =	3,802	(sum of 9)						

The Investment Timing Decision

- Problem 1: Investment Timing Decision
  - Some projects are more valuable if undertaken in the future
  - Examine start dates (*t*) for investment and calculate net future value for each date
    - ✓Discount net values back to present

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

It is important to explain that NPVs can be calculated at any point in time. Students are most familiar with time = 0. This kind of case shows how we must be flexible in our calculations. It is an “outside the box” concept and hard for students to grasp.

Investment Timing

Example

You own a large tract of inaccessible timber. To harvest it, you have to invest a substantial amount in access roads and other facilities. The longer you wait, the higher the investment required. On the other hand, lumber prices will rise as you wait, and the trees will keep growing, although at a gradually decreasing rate. Given the following data and a 10% discount rate, when should you harvest?

	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

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

Answer: Year 4

Using the NPV Rule to Choose among Projects

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.

$$\text{Equivalent annual cost (annuity)} = \frac{\text{present value of cash flows}}{\text{annuity factor}}$$

Equivalent Annual Cash Flows

Example

Given the following COSTS from operating two machines and a 6% cost of capital, which machine has the lower equivalent annual cost?

	Year					
Mach.	0	1	2	3	PV@6%	E.A.C.
A	15	5	5	5	28.37	10.61
B	10	6	6		21.00	11.45

Equivalent Annual Annuity

Example (with a twist)

*Select one of the two following projects, based on **highest** "equivalent annual annuity" (r = 9%).*

Project	C_0	C_1	C_2	C_3	C_4	NPV	EAA
A	−15	4.9	5.2	5.9	6.2	2.82	.87
B	−20	8.1	8.7	10.4		2.78	1.10

Using the NPV Rule to Choose among Projects

Problem 3: When to Replace an Old Machine

Example

A machine is expected to produce a net inflow of $4,000 this year and $4,000 next year before breaking. You can replace it now with a machine that costs $15,000 and will produce an inflow of $8,000 per year for three years. Should you replace now or wait a year?

In practice, the point at which equipment is replaced reflects economics, not physical collapse. *We must decide when to replace.*

Using the NPV Rule to Choose among Projects

Problem 3: When to Replace an Old Machine

Example - continued

	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.

Using the NPV Rule to Choose among Projects

Problem 4: Cost of Excess Capacity

Example

A computer system costs $500,000 to buy and operate at a discount rate of 6% and lasts five years.

- ✓Equivalent annual cost of $118,700
- ✓Undertaking project in year 4 has a present value of $118{,}700/(1.06)^4$, or about $94,000

When recognized, the NPV of the project may prove to be negative. If so, we still need to check whether it is worthwhile undertaking the project now and abandoning it later, when the excess capacity of the present system disappears.