

Module 7

Capital Budgeting

FINE 3010, Financial Management
Prof. Renping Li, Tulane University

Goals

- How to decide what project(s) to do? The tool is the NPV rule

Goals

- How to decide what project(s) to do? The tool is the NPV rule
- But to use NPV, we need a project's cash flows

Goals

- How to decide what project(s) to do? The tool is the NPV rule
- But to use NPV, we need a project's cash flows
- Here, combine what we know about accounting and cash flow effects ([Module 2](#)) with the NPV rule ([Module 6](#)), to decide whether or not to accept a project

Goals

- How to decide what project(s) to do? The tool is the NPV rule
- But to use NPV, we need a project's cash flows
- Here, combine what we know about accounting and cash flow effects ([Module 2](#)) with the NPV rule ([Module 6](#)), to decide whether or not to accept a project
- **Capital budgeting**, the process of analyzing capital investment opportunities (“projects”) and deciding which ones to accept

Module 7, Part 1

Project Cash Flow

Identify Project-Level Cash Flow from Three Sources

- Cash flows from a project come from three basic sources,

Identify Project-Level Cash Flow from Three Sources

- Cash flows from a project come from three basic sources,

$$\begin{aligned}\text{Total cash flow from a project} &= \text{Cash flow from capital investments} \\ &\quad + \text{Operating cash flow before accounting for } \Delta\text{NWC} \\ &\quad + \text{Cash flow from changes in working capital}\end{aligned}$$

- Capital investments happen mostly at $t = 0$

Source 1, Cash Flow from Capital Investments

- If the project requires spending money on investment to get started (e.g., purchasing a building), that is a negative cash flow

Source 1, Cash Flow from Capital Investments

- If the project requires spending money on investment to get started (e.g., purchasing a building), that is a negative cash flow
- Usually capitalized and depreciated over time from an accounting perspective, in this course always “straight-line” depreciation,

$$\text{Annual depreciation} = \frac{\text{Investment} - \text{Salvage value}}{\text{Expected life}}$$

Source 2, Operating Cash Flow before Accounting for ΔNWC

- We hope to get (mostly) positive cash flows from the project while it operates

Source 2, Operating Cash Flow before Accounting for ΔNWC

- We hope to get (mostly) positive cash flows from the project while it operates
- How to account for depreciation (and the depreciation tax shield)? Build a project-level income statement,

Source 2, Operating Cash Flow before Accounting for ΔNWC

- We hope to get (mostly) positive cash flows from the project while it operates
- How to account for depreciation (and the depreciation tax shield)? Build a project-level income statement,

Revenue from the project

— Cash expenses for the project

— Depreciation for project-specific capital investment

Project-specific EBIT

— Taxes (tax rate times project-specific EBIT)

Project-specific net income

Source 2, Operating Cash Flow before Accounting for ΔNWC

- We hope to get (mostly) positive cash flows from the project while it operates
- How to account for depreciation (and the depreciation tax shield)? Build a project-level income statement,

Revenue from the project

— Cash expenses for the project

— Depreciation for project-specific capital investment

Project-specific EBIT

— Taxes (tax rate times project-specific EBIT)

Project-specific net income

- Note, revenue minus cash expenses is called the “gross profit”

Three Equivalent Methods

- Three alternative (and equivalent) ways to get operating cash flow before accounting for ΔNWC ,

Three Equivalent Methods

- Three alternative (and equivalent) ways to get operating cash flow before accounting for ΔNWC ,
1. **Cash in, cash out**, Revenue — Cash expenses — Taxes
 - “Cash expenses” means non-cash expenses such as depreciation are not included

Three Equivalent Methods

- Three alternative (and equivalent) ways to get operating cash flow before accounting for ΔNWC ,
1. **Cash in, cash out**, Revenue – Cash expenses – Taxes
 - “Cash expenses” means non-cash expenses such as depreciation are not included
 2. **Adjusted accounting profits**, Net income + Depreciation

Three Equivalent Methods

- Three alternative (and equivalent) ways to get operating cash flow before accounting for ΔNWC ,
1. **Cash in, cash out**, Revenue – Cash expenses – Taxes
 - “Cash expenses” means non-cash expenses such as depreciation are not included
 2. **Adjusted accounting profits**, Net income + Depreciation
 3. **Add back the depreciation tax shield**,
 $(\text{Revenue} - \text{Cash expenses}) \times (1 - \text{tax rate}) + \text{Depreciation} \times \text{tax rate}$

Example, Depreciation and Tax Shield in Operating Cash Flow

- A project requires an investment of \$2,000, producing gross profits (revenues less cash expenses) of \$1,100 in year 1 (and \$1,300 in year 2). The initial investment can be depreciated at \$1,000 per year. The corporate tax rate is 21%

Example, Depreciation and Tax Shield in Operating Cash Flow

- A project requires an investment of \$2,000, producing gross profits (revenues less cash expenses) of \$1,100 in year 1 (and \$1,300 in year 2). The initial investment can be depreciated at \$1,000 per year. The corporate tax rate is 21%
- Calculate the operating cash flow before accounting for ΔNWC for year 1, using the three methods,
 1. Cash in, cash out, Revenue – Cash expenses – Taxes
 2. Adjusted accounting profits, Net income + Depreciation
 3. Add back the depreciation tax shield,
 $(\text{Revenue} - \text{Cash expenses})(1 - t) + \text{Depreciation} \times t$

Example, Depreciation and Tax Shield in Operating Cash Flow

Method 1, cash in, cash
out

Item	\$
Gross profit	1,100
Taxes	21
Cash flow	1,079

- Method 1, the challenge is to calculate the tax correctly,
 $(1,100 - 1,000) \times 21\% = 21$ (gross profit is revenue minus cash expenses)

Example, Depreciation and Tax Shield in Operating Cash Flow

Method 1, cash in, cash out

Item	\$
Gross profit	1,100
Taxes	21
Cash flow	1,079

Method 2, adjusted profits

Item	\$
Gross profit	1,100
Depreciation	1,000
EBIT	100
Taxes	21
Net income	79
+ Depreciation	1,000
Cash flow	1,079

- Method 1, the challenge is to calculate the tax correctly,
 $(1,100 - 1,000) \times 21\% = 21$ (gross profit is revenue minus cash expenses)

Example, Depreciation and Tax Shield in Operating Cash Flow

Method 1, cash in, cash out

Item	\$
Gross profit	1,100
Taxes	21
Cash flow	1,079

Method 2, adjusted profits

Item	\$
Gross profit	1,100
Depreciation	1,000
EBIT	100
Taxes	21
Net income	79
+ Depreciation	1,000
Cash flow	1,079

Method 3, tax shield

Item	\$
Gross profit $\times (1 - t)$	869
Depreciation tax shield	210
Cash flow	1,079

- Method 1, the challenge is to calculate the tax correctly,
 $(1,100 - 1,000) \times 21\% = 21$ (gross profit is revenue minus cash expenses)

Example, Depreciation and Tax Shield in Operating Cash Flow

Method 1, cash in, cash out

Item	\$
Gross profit	1,100
Taxes	21
Cash flow	1,079

Method 2, adjusted profits

Item	\$
Gross profit	1,100
Depreciation	1,000
EBIT	100
Taxes	21
Net income	79
+ Depreciation	1,000
Cash flow	1,079

Method 3, tax shield

Item	\$
Gross profit $\times (1 - t)$	869
Depreciation tax shield	210
Cash flow	1,079

- Method 1, the challenge is to calculate the tax correctly,
 $(1,100 - 1,000) \times 21\% = 21$ (gross profit is revenue minus cash expenses)
- All three methods give \$1,079

Source 3, Cash Flow from Changes in Working Capital

- Almost every project requires some working capital, e.g., an inventory of raw materials before production starts, accounts receivable rising as sales start

Source 3, Cash Flow from Changes in Working Capital

- Almost every project requires some working capital, e.g., an inventory of raw materials before production starts, accounts receivable rising as sales start
- This build-up of working capital is a negative cash flow

Source 3, Cash Flow from Changes in Working Capital

- Almost every project requires some working capital, e.g., an inventory of raw materials before production starts, accounts receivable rising as sales start
- This build-up of working capital is a negative cash flow
- Over the project's life, NWC can keep going up (or start to go down), giving additional negative (or positive) cash flows in the years beyond $t = 0$

Source 3, Cash Flow from Changes in Working Capital

- Almost every project requires some working capital, e.g., an inventory of raw materials before production starts, accounts receivable rising as sales start
- This build-up of working capital is a negative cash flow
- Over the project's life, NWC can keep going up (or start to go down), giving additional negative (or positive) cash flows in the years beyond $t = 0$
- Working capital is often recovered at the end of the project (inventories consumed, customers pay their bills)

Recap of Part 1

- Total project cash flow = capital investments + operating cash flow before accounting for ΔNWC + changes in working capital

Recap of Part 1

- Total project cash flow = capital investments + operating cash flow before accounting for ΔNWC + changes in working capital
- Depreciation is not a cash flow, but its tax shield is, three equivalent methods give the operating cash flow

Recap of Part 1

- Total project cash flow = capital investments + operating cash flow before accounting for ΔNWC + changes in working capital
- Depreciation is not a cash flow, but its tax shield is, three equivalent methods give the operating cash flow
- Working capital builds up early, can keep changing over the life, and is often recovered at the end

Recap of Part 1

- Total project cash flow = capital investments + operating cash flow before accounting for ΔNWC + changes in working capital
- Depreciation is not a cash flow, but its tax shield is, three equivalent methods give the operating cash flow
- Working capital builds up early, can keep changing over the life, and is often recovered at the end
- Lay the years out in a table, then discount the total cash flows

Module 7, Part 2

Putting It All Together, a Data Center

Example, Putting It All Together

- A company is considering building a new data center which costs \$1 billion (\$1,000 million) and will last 5 years. It will be depreciated straight-line over 5 years with a salvage value of \$200 million. The data center can also be sold at $t = 5$ for \$200 million

Example, Putting It All Together

- A company is considering building a new data center which costs \$1 billion (\$1,000 million) and will last 5 years. It will be depreciated straight-line over 5 years with a salvage value of \$200 million. The data center can also be sold at $t = 5$ for \$200 million
- The data center requires an initial increase in net working capital of \$100 million at $t = 0$ (spare servers and parts), recovered fully at $t = 5$

Example, Putting It All Together

- A company is considering building a new data center which costs \$1 billion (\$1,000 million) and will last 5 years. It will be depreciated straight-line over 5 years with a salvage value of \$200 million. The data center can also be sold at $t = 5$ for \$200 million
- The data center requires an initial increase in net working capital of \$100 million at $t = 0$ (spare servers and parts), recovered fully at $t = 5$
- Renting out its computing capacity brings in \$200 million a year after operating costs (electricity, staff, and so on), which raises the company's profits

Example, Putting It All Together

- A company is considering building a new data center which costs \$1 billion (\$1,000 million) and will last 5 years. It will be depreciated straight-line over 5 years with a salvage value of \$200 million. The data center can also be sold at $t = 5$ for \$200 million
- The data center requires an initial increase in net working capital of \$100 million at $t = 0$ (spare servers and parts), recovered fully at $t = 5$
- Renting out its computing capacity brings in \$200 million a year after operating costs (electricity, staff, and so on), which raises the company's profits
- The corporate tax rate is 21%, and the discount rate is 8%

Example, Putting It All Together

- A company is considering building a new data center which costs \$1 billion (\$1,000 million) and will last 5 years. It will be depreciated straight-line over 5 years with a salvage value of \$200 million. The data center can also be sold at $t = 5$ for \$200 million
- The data center requires an initial increase in net working capital of \$100 million at $t = 0$ (spare servers and parts), recovered fully at $t = 5$
- Renting out its computing capacity brings in \$200 million a year after operating costs (electricity, staff, and so on), which raises the company's profits
- The corporate tax rate is 21%, and the discount rate is 8%
- Should the company build the data center or not?

Example, Putting It All Together

- Solution (\$ millions),

Year	0	1	2	3	4	5
Gross profit		200	200	200	200	200
Depreciation		160	160	160	160	160
EBIT		40	40	40	40	40
Net income		31.6	31.6	31.6	31.6	31.6
+ Depreciation		160	160	160	160	160
Operating cash flows		191.6	191.6	191.6	191.6	191.6
Capital investment	-1,000					
Sale of the data center						200
Working capital	-100					100
Total cash flows	-1,100	191.6	191.6	191.6	191.6	491.6
NPV	-130.82					

Example, Putting It All Together

- Solution (\$ millions),
 - **Capital investment**, 1,000 at $t = 0$ (negative cash flow), and +200 at $t = 5$ from the sale of the data center

Example, Putting It All Together

- Solution (\$ millions),
 - **Capital investment**, 1,000 at $t = 0$ (negative cash flow), and +200 at $t = 5$ from the sale of the data center
 - **Working capital**, an increase of 100 at $t = 0$ (negative cash flow), and +100 at $t = 5$ from its reduction. Exactly opposite cash flows, but we cannot ignore them because of the time value of money

Example, Putting It All Together

- Solution (\$ millions),
 - **Capital investment**, 1,000 at $t = 0$ (negative cash flow), and +200 at $t = 5$ from the sale of the data center
 - **Working capital**, an increase of 100 at $t = 0$ (negative cash flow), and +100 at $t = 5$ from its reduction. Exactly opposite cash flows, but we cannot ignore them because of the time value of money
 - **Operating cash flow before accounting for ΔNWC** , in years 1–5 the rental income adds 200 to gross profits. Depreciation rises by $(1,000 - 200)/5 = 160$ per year, a net 40 higher EBIT. After taxes and adding back depreciation, operating cash flow rises by 191.6 each year

Example, Putting It All Together

- Solution (\$ millions),
 - **Capital investment**, 1,000 at $t = 0$ (negative cash flow), and +200 at $t = 5$ from the sale of the data center
 - **Working capital**, an increase of 100 at $t = 0$ (negative cash flow), and +100 at $t = 5$ from its reduction. Exactly opposite cash flows, but we cannot ignore them because of the time value of money
 - **Operating cash flow before accounting for ΔNWC** , in years 1–5 the rental income adds 200 to gross profits. Depreciation rises by $(1,000 - 200)/5 = 160$ per year, a net 40 higher EBIT. After taxes and adding back depreciation, operating cash flow rises by 191.6 each year
- Putting it all together, $NPV = -\$130.82$ million, so the company should not build the data center

Module 7, Part 3

The Principles behind Project Cash Flows

General Principles for Identifying Project-Level Cash Flow

- Look back at the data center table. It quietly followed four principles,

General Principles for Identifying Project-Level Cash Flow

- Look back at the data center table. It quietly followed four principles,
 1. Discount cash flows, not accounting profits

General Principles for Identifying Project-Level Cash Flow

- Look back at the data center table. It quietly followed four principles,
 1. Discount cash flows, not accounting profits
 2. Ignore financing effects (assume all-equity financing)

General Principles for Identifying Project-Level Cash Flow

- Look back at the data center table. It quietly followed four principles,
 1. Discount cash flows, not accounting profits
 2. Ignore financing effects (assume all-equity financing)
 3. Don't forget about depreciation and taxes

General Principles for Identifying Project-Level Cash Flow

- Look back at the data center table. It quietly followed four principles,
 1. Discount cash flows, not accounting profits
 2. Ignore financing effects (assume all-equity financing)
 3. Don't forget about depreciation and taxes
 4. Only consider incremental cash flows

Principle 1, Discount Cash Flows, Not Accounting Profits

- Crucially, accounting profits are NOT cash flows

Principle 1, Discount Cash Flows, Not Accounting Profits

- Crucially, accounting profits are NOT cash flows
- Issues, the timing of capital expenditures, depreciation, working capital, and more

Principle 1, Discount Cash Flows, Not Accounting Profits

- Crucially, accounting profits are NOT cash flows
- Issues, the timing of capital expenditures, depreciation, working capital, and more
- **Cash flow approach** (the **right** approach), discount the actual cash flows to their present value

Principle 1, Discount Cash Flows, Not Accounting Profits

- Crucially, accounting profits are NOT cash flows
- Issues, the timing of capital expenditures, depreciation, working capital, and more
- **Cash flow approach** (the **right** approach), discount the actual cash flows to their present value
- **Accounting approach** (the **wrong** approach, it can lead to erroneous decisions), consider accounting income

Principle 1, Discount Cash Flows, Not Accounting Profits

- Crucially, accounting profits are NOT cash flows
- Issues, the timing of capital expenditures, depreciation, working capital, and more
- **Cash flow approach** (the **right** approach), discount the actual cash flows to their present value
- **Accounting approach** (the **wrong** approach, it can lead to erroneous decisions), consider accounting income
- In the data center table, we discounted the operating cash flows (\$191.6 million a year), not the net income (\$31.6 million)

Cash Flow vs. Accounting Income

- A project costs \$2,000 and is expected to last 2 years, producing cash income of \$1,500 and \$500, respectively. The cost can be depreciated at \$1,000 per year. Given a 10% required return, compare the NPV using accounting income to the NPV using cash flow

Cash Flow vs. Accounting Income

- A project costs \$2,000 and is expected to last 2 years, producing cash income of \$1,500 and \$500, respectively. The cost can be depreciated at \$1,000 per year. Given a 10% required return, compare the NPV using accounting income to the NPV using cash flow

	Year 1	Year 2
Cash inflow	\$1,500	\$500
Depreciation	−\$1,000	−\$1,000
Accounting income	+\$500	−\$500

Cash Flow vs. Accounting Income

- A project costs \$2,000 and is expected to last 2 years, producing cash income of \$1,500 and \$500, respectively. The cost can be depreciated at \$1,000 per year. Given a 10% required return, compare the NPV using accounting income to the NPV using cash flow

	Year 1	Year 2
Cash inflow	\$1,500	\$500
Depreciation	−\$1,000	−\$1,000
Accounting income	+\$500	−\$500

$$\text{Accounting income NPV} = \frac{\$500}{1.10} - \frac{\$500}{1.10^2} = \$41.32$$

Cash Flow vs. Accounting Income

- A project costs \$2,000 and is expected to last 2 years, producing cash income of \$1,500 and \$500, respectively. The cost can be depreciated at \$1,000 per year. Given a 10% required return, compare the NPV using accounting income to the NPV using cash flow

	Year 1	Year 2
Cash inflow	\$1,500	\$500
Depreciation	−\$1,000	−\$1,000
Accounting income	+\$500	−\$500

	Today	Year 1	Year 2
Cash inflow		\$1,500	\$500
Project cost	−\$2,000		
Total cash flow	−\$2,000	+\$1,500	+\$500

$$\text{Accounting income NPV} = \frac{\$500}{1.10} - \frac{\$500}{1.10^2} = \$41.32$$

Cash Flow vs. Accounting Income

- A project costs \$2,000 and is expected to last 2 years, producing cash income of \$1,500 and \$500, respectively. The cost can be depreciated at \$1,000 per year. Given a 10% required return, compare the NPV using accounting income to the NPV using cash flow

	Year 1	Year 2
Cash inflow	\$1,500	\$500
Depreciation	−\$1,000	−\$1,000
Accounting income	+\$500	−\$500

$$\text{Accounting income NPV} = \frac{\$500}{1.10} - \frac{\$500}{1.10^2} = \$41.32$$

$$\text{Cash flow NPV} = \frac{\$1,500}{1.10} + \frac{\$500}{1.10^2} - \$2,000 = -\$223.14$$

	Today	Year 1	Year 2
Cash inflow		\$1,500	\$500
Project cost	−\$2,000		
Total cash flow	−\$2,000	+\$1,500	+\$500

Cash Flow vs. Accounting Income

- A project costs \$2,000 and is expected to last 2 years, producing cash income of \$1,500 and \$500, respectively. The cost can be depreciated at \$1,000 per year. Given a 10% required return, compare the NPV using accounting income to the NPV using cash flow

	Year 1	Year 2
Cash inflow	\$1,500	\$500
Depreciation	−\$1,000	−\$1,000
Accounting income	+\$500	−\$500

$$\text{Accounting income NPV} = \frac{\$500}{1.10} - \frac{\$500}{1.10^2} = \$41.32$$

$$\text{Cash flow NPV} = \frac{\$1,500}{1.10} + \frac{\$500}{1.10^2} - \$2,000 = -\$223.14$$

- This project is clearly a loser!

Principle 2, Separate the Investment and Financing Decisions

- Capital budgeting focuses on the investment decision
 - Do not conflate it with the financing decision of how to pay for the project (cash on hand, new debt, or new equity)

Principle 2, Separate the Investment and Financing Decisions

- Capital budgeting focuses on the investment decision
 - Do not conflate it with the financing decision of how to pay for the project (cash on hand, new debt, or new equity)
- So we ignore how the project is financed, by assuming 100% equity financing for every project
 - In the examples, no interest is subtracted when calculating operating cash flows, and no interest tax shield is counted

Principle 2, Separate the Investment and Financing Decisions

- Capital budgeting focuses on the investment decision
 - Do not conflate it with the financing decision of how to pay for the project (cash on hand, new debt, or new equity)
- So we ignore how the project is financed, by assuming 100% equity financing for every project
 - In the examples, no interest is subtracted when calculating operating cash flows, and no interest tax shield is counted
 - The effects of interest (and the interest tax shield) enter when we *separately* consider financing decisions

Principle 2, Separate the Investment and Financing Decisions

- Capital budgeting focuses on the investment decision
 - Do not conflate it with the financing decision of how to pay for the project (cash on hand, new debt, or new equity)
- So we ignore how the project is financed, by assuming 100% equity financing for every project
 - In the examples, no interest is subtracted when calculating operating cash flows, and no interest tax shield is counted
 - The effects of interest (and the interest tax shield) enter when we *separately* consider financing decisions
- The data center table has no interest line, even if the company borrows to build it

Principle 3, Don't Forget about Depreciation and Taxes

- Depreciation can get quite complicated!

Principle 3, Don't Forget about Depreciation and Taxes

- Depreciation can get quite complicated!
- Depreciation is not a cash flow, but it lowers taxable income and so the taxes the project pays, the depreciation tax shield

Principle 3, Don't Forget about Depreciation and Taxes

- Depreciation can get quite complicated!
- Depreciation is not a cash flow, but it lowers taxable income and so the taxes the project pays, the depreciation tax shield
- Different depreciation schedules, in this course we stick to “straight-line” depreciation, as in the data center, $(1,000 - 200)/5 = \$160$ million a year

Principle 4, Only Consider Incremental Cash Flows

- We need to discount **incremental** cash flows. What does “incremental” mean in capital budgeting?

Principle 4, Only Consider Incremental Cash Flows

- We need to discount **incremental** cash flows. What does “incremental” mean in capital budgeting?
- Ask yourself, “would the cash flow still exist if the project did not exist?”
 - If yes, do NOT include it in the analysis
 - If no, include it

Principle 4, Only Consider Incremental Cash Flows

- We need to discount **incremental** cash flows. What does “incremental” mean in capital budgeting?
- Ask yourself, “would the cash flow still exist if the project did not exist?”
 - If yes, do NOT include it in the analysis
 - If no, include it

Incremental cash flow = Cash flow with the project – Cash flow without it

Principle 4, Only Consider Incremental Cash Flows

- We need to discount **incremental** cash flows. What does “incremental” mean in capital budgeting?
- Ask yourself, “would the cash flow still exist if the project did not exist?”
 - If yes, do NOT include it in the analysis
 - If no, include it

Incremental cash flow = Cash flow with the project – Cash flow without it

- In the data center table, the rental income and the spare parts exist only because of the data center, so they count

Incremental Cash Flows, a Few Rules That Are Easy to Forget

- a. Include all indirect effects

Incremental Cash Flows, a Few Rules That Are Easy to Forget

- a. Include all indirect effects
- b. Ignore sunk costs

Incremental Cash Flows, a Few Rules That Are Easy to Forget

- a. Include all indirect effects
- b. Ignore sunk costs
- c. Recognize opportunity costs

Incremental Cash Flows, a Few Rules That Are Easy to Forget

- a. Include all indirect effects
- b. Ignore sunk costs
- c. Recognize opportunity costs
- d. Beware of allocated overhead costs

Incremental Cash Flows, a Few Rules That Are Easy to Forget

- a. Include all indirect effects
- b. Ignore sunk costs
- c. Recognize opportunity costs
- d. Beware of allocated overhead costs
- e. Recognize investments in working capital

Incremental Cash Flows, a Few Rules That Are Easy to Forget

- a. Include all indirect effects
- b. Ignore sunk costs
- c. Recognize opportunity costs
- d. Beware of allocated overhead costs
- e. Recognize investments in working capital
- f. Remember terminal cash flows

Rule a, Indirect Effects

- What are indirect effects? E.g., cannibalization and externalities



Rule a, Indirect Effects

- What are indirect effects? E.g., cannibalization and externalities
- Nintendo plans a new-generation gaming console. It requires an investment of \$200m and produces cash flows of \$400m and \$800m in years 1 and 2. Looks like a great investment!



Rule a, Indirect Effects

- What are indirect effects? E.g., cannibalization and externalities
- Nintendo plans a new-generation gaming console. It requires an investment of \$200m and produces cash flows of \$400m and \$800m in years 1 and 2. Looks like a great investment!
- But the launch will hurt sales of the older console, forecast to create \$800m and \$1,000m in years 1 and 2, only \$500m and \$400m with the new one on the market



Rule a, Indirect Effects

- What are indirect effects? E.g., cannibalization and externalities
- Nintendo plans a new-generation gaming console. It requires an investment of \$200m and produces cash flows of \$400m and \$800m in years 1 and 2. Looks like a great investment!
- But the launch will hurt sales of the older console, forecast to create \$800m and \$1,000m in years 1 and 2, only \$500m and \$400m with the new one on the market
- What is the **incremental** cash flow of the new console?



Rule a, Indirect Effects

- Solution (\$ millions),

	$t = 0$	$t = 1$	$t = 2$
Cash flow from the old console without the new one		800	1,000
Cash flow from the old console with the new one		500	400
Cash flow from investment in and sales of the new one	-200	400	800
Incremental cash flow of the new console	<u>-200</u>	<u>400 - 300 = 100</u>	<u>800 - 600 = 200</u>

Rule b, Sunk Costs

- **Sunk costs**, expenses already paid, or which cannot be changed by the investment decision
 - E.g., anything done in the past (previous R&D), or anything that can no longer be changed (rent under an unbreakable lease)



Rule b, Sunk Costs

- **Sunk costs**, expenses already paid, or which cannot be changed by the investment decision
 - E.g., anything done in the past (previous R&D), or anything that can no longer be changed (rent under an unbreakable lease)
- They do not affect incremental cash flows, so they do not affect the NPV of a decision. Ignore them!



Rule b, Sunk Costs

- **Sunk costs**, expenses already paid, or which cannot be changed by the investment decision
 - E.g., anything done in the past (previous R&D), or anything that can no longer be changed (rent under an unbreakable lease)
- They do not affect incremental cash flows, so they do not affect the NPV of a decision. Ignore them!
- Many sunk costs are “related” to a project, but no longer incremental if the current decision does not affect them



Example, Sunk Costs

- Your company has developed a new product that is almost ready to launch. The R&D cost \$0.6 million and was completed last year
- Launching requires another \$1 million investment (marketing and so on), with a present value of future operating cash flows of \$1.5 million

Example, Sunk Costs

- Your company has developed a new product that is almost ready to launch. The R&D cost \$0.6 million and was completed last year
- Launching requires another \$1 million investment (marketing and so on), with a present value of future operating cash flows of \$1.5 million
- Is this project a good idea today?

Example, Sunk Costs

- Your company has developed a new product that is almost ready to launch. The R&D cost \$0.6 million and was completed last year
- Launching requires another \$1 million investment (marketing and so on), with a present value of future operating cash flows of \$1.5 million
- Is this project a good idea today?
- Was this project a good idea last year?

Rule c, Opportunity Costs

- A resource is almost never “free”
 - E.g., a warehouse the company already owns is not free, the firm could use it for another project, rent it out, or sell it

Rule c, Opportunity Costs

- A resource is almost never “free”
 - E.g., a warehouse the company already owns is not free, the firm could use it for another project, rent it out, or sell it
- Recognize and include the **opportunity cost** of every resource, the value of its “best alternative use”

Rule c, Opportunity Costs

- A resource is almost never “free”
 - E.g., a warehouse the company already owns is not free, the firm could use it for another project, rent it out, or sell it
- Recognize and include the **opportunity cost** of every resource, the value of its “best alternative use”
- E.g., you plan a new factory building that costs \$10m to construct, on a piece of land you already own (and do not need for anything else). Alternatively, you could sell the land for \$3m

Rule c, Opportunity Costs

- A resource is almost never “free”
 - E.g., a warehouse the company already owns is not free, the firm could use it for another project, rent it out, or sell it
- Recognize and include the **opportunity cost** of every resource, the value of its “best alternative use”
- E.g., you plan a new factory building that costs \$10m to construct, on a piece of land you already own (and do not need for anything else). Alternatively, you could sell the land for \$3m
- What is the actual cost of building the factory?

Rule d, Overhead

- **Overhead**, ongoing administrative expenses of a business that cannot be attributed to any specific business activity, but are still necessary for the business to function
 - E.g., rent and utilities of the central office, top management salaries

Rule d, Overhead

- **Overhead**, ongoing administrative expenses of a business that cannot be attributed to any specific business activity, but are still necessary for the business to function
 - E.g., rent and utilities of the central office, top management salaries
- The principle of incremental cash flows says only *changes* in overhead that result from a project count

Rule e, Working Capital

- If a project requires additional investment in net working capital (and most do!), those cash flows belong in the analysis
 - Easy to forget! (The data center example had them)

Rule e, Working Capital

- If a project requires additional investment in net working capital (and most do!), those cash flows belong in the analysis
 - Easy to forget! (The data center example had them)
 - Only changes in NWC that are incremental to the project count

Rule e, Working Capital

- If a project requires additional investment in net working capital (and most do!), those cash flows belong in the analysis
 - Easy to forget! (The data center example had them)
 - Only changes in NWC that are incremental to the project count
- Working capital often keeps changing during the project, and is often recovered at the end

Rule e, Working Capital

- If a project requires additional investment in net working capital (and most do!), those cash flows belong in the analysis
 - Easy to forget! (The data center example had them)
 - Only changes in NWC that are incremental to the project count
- Working capital often keeps changing during the project, and is often recovered at the end
- Common mistakes,
 1. Forgetting about working capital entirely
 2. Forgetting that working capital may change during the life of the project
 3. Forgetting that working capital is often recovered at the end of the project

Rule f, Terminal Cash Flows

- At the end, there may be cash flows from shutting down the project, the “terminal” cash flows
 - E.g., selling the machines and equipment of the project, a positive cash flow!

Rule f, Terminal Cash Flows

- At the end, there may be cash flows from shutting down the project, the “terminal” cash flows
 - E.g., selling the machines and equipment of the project, a positive cash flow!
- Keep track of the tax consequences, if capital is sold for more than its depreciated book value there is a tax bill, and vice versa

Rule f, Terminal Cash Flows

- At the end, there may be cash flows from shutting down the project, the “terminal” cash flows
 - E.g., selling the machines and equipment of the project, a positive cash flow!
- Keep track of the tax consequences, if capital is sold for more than its depreciated book value there is a tax bill, and vice versa
- E.g., in the data center example, suppose it could be sold for \$500 million at $t = 5$. It has been depreciated to \$200 million, so the company pays taxes on the gain,

$$(500 - 200) \times 21\% = \$63 \text{ million}$$

Rule f, Terminal Cash Flows

- At the end, there may be cash flows from shutting down the project, the “terminal” cash flows
 - E.g., selling the machines and equipment of the project, a positive cash flow!
- Keep track of the tax consequences, if capital is sold for more than its depreciated book value there is a tax bill, and vice versa
- E.g., in the data center example, suppose it could be sold for \$500 million at $t = 5$. It has been depreciated to \$200 million, so the company pays taxes on the gain,

$$(500 - 200) \times 21\% = \$63 \text{ million}$$

- The net (after-tax) proceeds are $500 - 63 = \$437$ million, and now the NPV is positive (+\$30.48 million)

Example, the Data Center with a Higher Terminal Cash Flow

- Solution (\$ millions),

Year	0	1	2	3	4	5
Gross profit		200	200	200	200	200
Depreciation		160	160	160	160	160
EBIT		40	40	40	40	40
Net income		31.6	31.6	31.6	31.6	31.6
+ Depreciation		160	160	160	160	160
Operating cash flows		191.6	191.6	191.6	191.6	191.6
Capital investment	-1,000					
Sale of the data center (after tax)						437
Working capital	-100					100
Total cash flows	-1,100	191.6	191.6	191.6	191.6	728.6
NPV	30.48					
IRR	8.8%					

Rule f, Terminal Cash Flows Can Be Negative

- Terminal cash flows can also be negative, e.g., if we have to pay to shut down the project



Rule f, Terminal Cash Flows Can Be Negative

- Terminal cash flows can also be negative, e.g., if we have to pay to shut down the project
- E.g., oil wells require “capping” when they no longer produce. Capping is expensive, so oil well projects are worth more if you do not cap them (although this is illegal!)



Rule f, Terminal Cash Flows Can Be Negative

- Terminal cash flows can also be negative, e.g., if we have to pay to shut down the project
- E.g., oil wells require “capping” when they no longer produce. Capping is expensive, so oil well projects are worth more if you do not cap them (although this is illegal!)
- But apparently many companies still do this, [Bloomberg](#), “It Pays to Not Pay Your Debts”



Practice Problem

- A firm plans a new manufacturing plant on a site it already owns, but the existing buildings must be demolished. Which of the following are incremental cash flows?
 - a. The market value of the site
 - b. The market value of the existing buildings
 - c. Demolition costs and site clearance
 - d. The cost of a new access road put in last year
 - e. Lost cash flows on other projects due to executive time spent on the new facility
 - f. Future depreciation of the new plant
 - g. The reduction in the firm's tax bill resulting from depreciation of the new plant
 - h. The initial investment in inventories of raw materials
 - i. Money already spent on engineering design of the new plant

Practice Problem

- a, b. The site and buildings could have been sold or put to another use. Their values are opportunity costs, treated as incremental cash outflows

Practice Problem

- a, b. The site and buildings could have been sold or put to another use. Their values are opportunity costs, treated as incremental cash outflows
- c. Demolition costs are incremental cash outflows

Practice Problem

- a, b. The site and buildings could have been sold or put to another use. Their values are opportunity costs, treated as incremental cash outflows
- c. Demolition costs are incremental cash outflows
- d. The cost of the access road is sunk and not incremental

Practice Problem

- a, b. The site and buildings could have been sold or put to another use. Their values are opportunity costs, treated as incremental cash outflows
- c. Demolition costs are incremental cash outflows
- d. The cost of the access road is sunk and not incremental
- e. Lost cash flows from other projects are incremental cash outflows (though not easily estimated)

Practice Problem

- a, b. The site and buildings could have been sold or put to another use. Their values are opportunity costs, treated as incremental cash outflows
- c. Demolition costs are incremental cash outflows
- d. The cost of the access road is sunk and not incremental
- e. Lost cash flows from other projects are incremental cash outflows (though not easily estimated)
- f. Depreciation is not a cash expense and should not be included, except as it affects taxes

Practice Problem

- a, b. The site and buildings could have been sold or put to another use. Their values are opportunity costs, treated as incremental cash outflows
- c. Demolition costs are incremental cash outflows
- d. The cost of the access road is sunk and not incremental
- e. Lost cash flows from other projects are incremental cash outflows (though not easily estimated)
- f. Depreciation is not a cash expense and should not be included, except as it affects taxes
- g. The reduction in tax due to depreciation is an addition to cash flow

Practice Problem

- a, b. The site and buildings could have been sold or put to another use. Their values are opportunity costs, treated as incremental cash outflows
- c. Demolition costs are incremental cash outflows
- d. The cost of the access road is sunk and not incremental
- e. Lost cash flows from other projects are incremental cash outflows (though not easily estimated)
- f. Depreciation is not a cash expense and should not be included, except as it affects taxes
- g. The reduction in tax due to depreciation is an addition to cash flow
- h. The initial investment in inventories is a cash outflow

Practice Problem

- a, b. The site and buildings could have been sold or put to another use. Their values are opportunity costs, treated as incremental cash outflows
- c. Demolition costs are incremental cash outflows
- d. The cost of the access road is sunk and not incremental
- e. Lost cash flows from other projects are incremental cash outflows (though not easily estimated)
- f. Depreciation is not a cash expense and should not be included, except as it affects taxes
- g. The reduction in tax due to depreciation is an addition to cash flow
- h. The initial investment in inventories is a cash outflow
- i. The expenditure on design is a sunk cost and not an incremental cash flow

Recap of Part 3

- Discount cash flows, not accounting profits, and ignore financing (all-equity)

Recap of Part 3

- Discount cash flows, not accounting profits, and ignore financing (all-equity)
- Depreciation is not a cash flow, but its tax shield is

Recap of Part 3

- Discount cash flows, not accounting profits, and ignore financing (all-equity)
- Depreciation is not a cash flow, but its tax shield is
- Only incremental cash flows count, would the cash flow exist without the project?

Recap of Part 3

- Discount cash flows, not accounting profits, and ignore financing (all-equity)
- Depreciation is not a cash flow, but its tax shield is
- Only incremental cash flows count, would the cash flow exist without the project?
- Count indirect effects, opportunity costs, working capital, and terminal cash flows (with the tax on any gain over book value), ignore sunk costs and allocated overhead

Module 7, Part 4

Full-Scale Capital Budgeting Problems

Example, the Data Center Again

- Recall the data center from Part 2 (\$ millions),
 - It costs 1,000 and lasts 5 years, depreciated straight-line to a salvage value of 200, and sold at $t = 5$ for 200

Example, the Data Center Again

- Recall the data center from Part 2 (\$ millions),
 - It costs 1,000 and lasts 5 years, depreciated straight-line to a salvage value of 200, and sold at $t = 5$ for 200
 - It needs 100 more net working capital at $t = 0$, recovered fully at $t = 5$

Example, the Data Center Again

- Recall the data center from Part 2 (\$ millions),
 - It costs 1,000 and lasts 5 years, depreciated straight-line to a salvage value of 200, and sold at $t = 5$ for 200
 - It needs 100 more net working capital at $t = 0$, recovered fully at $t = 5$
 - It brings in 200 a year after operating costs

Example, the Data Center Again

- Recall the data center from Part 2 (\$ millions),
 - It costs 1,000 and lasts 5 years, depreciated straight-line to a salvage value of 200, and sold at $t = 5$ for 200
 - It needs 100 more net working capital at $t = 0$, recovered fully at $t = 5$
 - It brings in 200 a year after operating costs
 - The corporate tax rate is 21%, and the discount rate is 8%

Example, the Data Center Again

- Recall the data center from Part 2 (\$ millions),
 - It costs 1,000 and lasts 5 years, depreciated straight-line to a salvage value of 200, and sold at $t = 5$ for 200
 - It needs 100 more net working capital at $t = 0$, recovered fully at $t = 5$
 - It brings in 200 a year after operating costs
 - The corporate tax rate is 21%, and the discount rate is 8%
- This time, build the table step by step

Example, the Data Center Again

- Solution (\$ millions), the operating cash flows first, then working capital, then the capital investment and the sale, then the totals

[illegible]

Example, the Data Center Again

- Solution (\$ millions), the operating cash flows first, then working capital, then the capital investment and the sale, then the totals

Year	0	1	2	3	4	5
Gross profit		200	200	200	200	200
Depreciation		160	160	160	160	160
EBIT		40	40	40	40	40
Net income		31.6	31.6	31.6	31.6	31.6
+ Depreciation		160	160	160	160	160
Operating cash flows		191.6	191.6	191.6	191.6	191.6

Example, the Data Center Again

- Solution (\$ millions), the operating cash flows first, then working capital, then the capital investment and the sale, then the totals

Year	0	1	2	3	4	5
Gross profit		200	200	200	200	200
Depreciation		160	160	160	160	160
EBIT		40	40	40	40	40
Net income		31.6	31.6	31.6	31.6	31.6
+ Depreciation		160	160	160	160	160
Operating cash flows		191.6	191.6	191.6	191.6	191.6
Working capital	-100					100

Example, the Data Center Again

- Solution (\$ millions), the operating cash flows first, then working capital, then the capital investment and the sale, then the totals

Year	0	1	2	3	4	5
Gross profit		200	200	200	200	200
Depreciation		160	160	160	160	160
EBIT		40	40	40	40	40
Net income		31.6	31.6	31.6	31.6	31.6
+ Depreciation		160	160	160	160	160
Operating cash flows		191.6	191.6	191.6	191.6	191.6
Working capital	-100					100
Capital investment	-1,000					
Sale of the data center						200

Example, the Data Center Again

- Solution (\$ millions), the operating cash flows first, then working capital, then the capital investment and the sale, then the totals

Year	0	1	2	3	4	5
Gross profit		200	200	200	200	200
Depreciation		160	160	160	160	160
EBIT		40	40	40	40	40
Net income		31.6	31.6	31.6	31.6	31.6
+ Depreciation		160	160	160	160	160
Operating cash flows		191.6	191.6	191.6	191.6	191.6
Working capital	-100					100
Capital investment	-1,000					
Sale of the data center						200
Total cash flows	-1,100	191.6	191.6	191.6	191.6	491.6
NPV	-130.82					

- $NPV = -\$130.82$ million, reject the project, the same answer as in Part 2

How to Attack a Full-Scale Problem

1. Build the project-level income statement year by year, then get the operating cash flow before accounting for ΔNWC

How to Attack a Full-Scale Problem

1. Build the project-level income statement year by year, then get the operating cash flow before accounting for ΔNWC
2. Lay out the working capital each year, the *changes* in NWC are the cash flows

How to Attack a Full-Scale Problem

1. Build the project-level income statement year by year, then get the operating cash flow before accounting for ΔNWC
2. Lay out the working capital each year, the *changes* in NWC are the cash flows
3. Add the capital investment at the start and the terminal cash flows at the end (after tax)

How to Attack a Full-Scale Problem

1. Build the project-level income statement year by year, then get the operating cash flow before accounting for ΔNWC
2. Lay out the working capital each year, the *changes* in NWC are the cash flows
3. Add the capital investment at the start and the terminal cash flows at the end (after tax)
4. Total the cash flows year by year, discount at the discount rate, and apply the NPV rule

Example 1, Growing Sales and a Taxed Sale of Equipment

- A company makes bottles and just developed a new bottle design
- The initial investment in machinery is \$6 million. The equipment is depreciated straight-line over 6 years to zero, but will actually be sold in 6 years for \$620,000 (so there are tax consequences)

Example 1, Growing Sales and a Taxed Sale of Equipment

- A company makes bottles and just developed a new bottle design
- The initial investment in machinery is \$6 million. The equipment is depreciated straight-line over 6 years to zero, but will actually be sold in 6 years for \$620,000 (so there are tax consequences)
- \$250,000 in working capital is required, all purchased immediately and recovered at the end

Example 1, Growing Sales and a Taxed Sale of Equipment

- A company makes bottles and just developed a new bottle design
- The initial investment in machinery is \$6 million. The equipment is depreciated straight-line over 6 years to zero, but will actually be sold in 6 years for \$620,000 (so there are tax consequences)
- \$250,000 in working capital is required, all purchased immediately and recovered at the end
- Sales are projected at 1 million bottles in the first year, growing at 5% a year over the six years. Production costs are \$2.00 per bottle, and each bottle sells for \$4.00

Example 1, Growing Sales and a Taxed Sale of Equipment

- A company makes bottles and just developed a new bottle design
- The initial investment in machinery is \$6 million. The equipment is depreciated straight-line over 6 years to zero, but will actually be sold in 6 years for \$620,000 (so there are tax consequences)
- \$250,000 in working capital is required, all purchased immediately and recovered at the end
- Sales are projected at 1 million bottles in the first year, growing at 5% a year over the six years. Production costs are \$2.00 per bottle, and each bottle sells for \$4.00
- The new design is phased out after 6 years. The tax rate is 21%, and the required rate of return is 12%

Example 1, Growing Sales and a Taxed Sale of Equipment

- A company makes bottles and just developed a new bottle design
- The initial investment in machinery is \$6 million. The equipment is depreciated straight-line over 6 years to zero, but will actually be sold in 6 years for \$620,000 (so there are tax consequences)
- \$250,000 in working capital is required, all purchased immediately and recovered at the end
- Sales are projected at 1 million bottles in the first year, growing at 5% a year over the six years. Production costs are \$2.00 per bottle, and each bottle sells for \$4.00
- The new design is phased out after 6 years. The tax rate is 21%, and the required rate of return is 12%
- What is the project's NPV?

Example 1, Growing Sales and a Taxed Sale of Equipment

- Operating cash flows (\$ thousands),

Year	1	2	3	4	5	6
Sales (thousand bottles)	1,000	1,050	1,103	1,158	1,216	1,276
Sales (\$)	4,000	4,200	4,410	4,631	4,862	5,105
Cost (\$)	2,000	2,100	2,205	2,315	2,431	2,553
Depreciation	1,000	1,000	1,000	1,000	1,000	1,000
EBIT	1,000	1,100	1,205	1,315	1,431	1,553
Taxes	210	231	253	276	301	326
Net income	790	869	952	1,039	1,130	1,227
+ Depreciation	1,000	1,000	1,000	1,000	1,000	1,000
Operating cash flows	1,790	1,869	1,952	2,039	2,130	2,227

Example 1, Growing Sales and a Taxed Sale of Equipment

- Terminal cash flow from the sale of the equipment (\$ thousands), the book value is zero so the whole sale price is taxed,

Terminal cash flows	\$
Sales price	620
Tax	130
Net income from sale	490

Example 1, Growing Sales and a Taxed Sale of Equipment

- Total cash flows (\$ thousands),

Year	0	1	2	3	4	5	6
Capital	−6,000						490
Working capital	−250						250
Operating cash flows		1,790	1,869	1,952	2,039	2,130	2,227
Total cash flows	−6,250	1,790	1,869	1,952	2,039	2,130	2,966
PV	−6,250	1,598	1,490	1,389	1,296	1,209	1,503
NPV	2,235						

Example 1, Growing Sales and a Taxed Sale of Equipment

- Total cash flows (\$ thousands),

Year	0	1	2	3	4	5	6
Capital	−6,000						490
Working capital	−250						250
Operating cash flows		1,790	1,869	1,952	2,039	2,130	2,227
Total cash flows	−6,250	1,790	1,869	1,952	2,039	2,130	2,966
PV	−6,250	1,598	1,490	1,389	1,296	1,209	1,503
NPV	2,235						

- The Excel solution is in the “Bottles” tab of Module 7 Excel Example.xlsx

Practice Problem

- A firm has developed a new mousetrap. It can go into production for an initial investment in equipment of \$6.3 million. The equipment will be depreciated straight-line over 6 years, but in fact can be sold after 6 years for \$695,000
- Working capital at each date must be maintained at 10% of next year's forecast sales. Production costs are \$1.80 per trap and the traps sell for \$7 each. The project ends in 6 years when the trap becomes obsolete. The tax rate is 40%, and the required rate of return is 11%

Year	0	1	2	3	4	5	6	After
Sales (million traps)	0	0.6	0.8	0.9	0.9	0.5	0.2	0

Practice Problem

- Suppose the firm can cut its working capital requirements in half with better inventory control. By how much does this increase the project NPV?

Practice Problem

- Suppose the firm can cut its working capital requirements in half with better inventory control. By how much does this increase the project NPV?
- Solution (\$ millions), working capital at each date is 10% of next year's sales,

Year	0	1	2	3	4	5	6
Sales units		0.600	0.800	0.900	0.900	0.500	0.200
Revenue	0.000	4.200	5.600	6.300	6.300	3.500	1.400
NWC	0.420	0.560	0.630	0.630	0.350	0.140	0.000
Cash flow from NWC	−0.420	−0.140	−0.070	0.000	0.280	0.210	0.140

Practice Problem

- With working capital requirements halved (\$ millions),

Year	0	1	2	3	4	5	6
New NWC	0.210	0.280	0.315	0.315	0.175	0.070	0.000
New cash flow from NWC	-0.210	-0.070	-0.035	0.000	0.140	0.105	0.070
Change in cash flow	0.210	0.070	0.035	0.000	-0.140	-0.105	-0.070

Practice Problem

- With working capital requirements halved (\$ millions),

Year	0	1	2	3	4	5	6
New NWC	0.210	0.280	0.315	0.315	0.175	0.070	0.000
New cash flow from NWC	-0.210	-0.070	-0.035	0.000	0.140	0.105	0.070
Change in cash flow	0.210	0.070	0.035	0.000	-0.140	-0.105	-0.070

- Discounting the changes in cash flow at 11%, the change in NPV is \$0.1095 million

Practice Problem

- A firm may upgrade its modem pool. It last upgraded 2 years ago, when it spent \$140 million on equipment with an assumed life of 5 years and an assumed salvage value of \$20 million for tax purposes. The firm uses straight-line depreciation. The old equipment can be sold today for \$100 million
- A new modem pool can be set up today for \$210 million. It has a 3-year life and is depreciated to zero straight-line. The new equipment increases sales by \$28 million per year and decreases operating costs by \$14 million per year. At the end of 3 years it is worthless. The tax rate is 30% and the discount rate is 9%

Practice Problem

- a. What is the net cash flow at time 0 if the old equipment is replaced?
- b. What are the incremental cash flows in years 1, 2, and 3?
- c. What is the NPV of the replacement project?
- d. What is the IRR of the replacement project?

Practice Problem

- a. Annual depreciation is $(\$140 - \$20)/5 = \$24$. Book value at the time of sale is $\$140 - 2 \times \$24 = \$92$

Practice Problem

- a. Annual depreciation is $(\$140 - \$20)/5 = \$24$. Book value at the time of sale is $\$140 - 2 \times \$24 = \$92$

Sales price = \$100, so net-of-tax proceeds from the sale are:
 $\$100 - [0.30 \times (\$100 - \$92)] = \$97.60$

Therefore, the net cash outlay at time 0 is $\$210 - \$97.60 = -\$112.40$.

- b. The project saves \$14 in operating costs and increases sales by \$28. The depreciation expense for the new machine would be \$70 per year.

Therefore, including the depreciation tax shield, operating cash flow increases by:
 $(\$28 + \$14) \times (1 - 0.30) + (\$70 \times 0.30) = \$50.40$ per year

c.
$$\begin{aligned} \text{NPV} &= -\$112.40 + \$50.40 \times ((1 \div 0.09) - \{1 \div [0.09(1 + 0.09)^3]\}) \\ &= \$15.18 \end{aligned}$$

- d. To find the internal rate of return, find the interest rate “r” that makes the Present Value of the inflows equal and opposite to the initial outflow. To do this set the PV of the three year annuity to \$112.40 and solve for the discount rate (r):
$$\begin{aligned} \$112.40 &= \$50.40 \times [1 \div r - 1 \div r \times (1 + r)^3] \\ r &= 16.43\% \end{aligned}$$

Key Takeaways

- A project's total cash flow adds capital investments, operating cash flow before accounting for ΔNWC , and changes in working capital

Key Takeaways

- A project's total cash flow adds capital investments, operating cash flow before accounting for ΔNWC , and changes in working capital
- Use cash flows, not accounting profits, treat financing separately, and remember the depreciation tax shield

Key Takeaways

- A project's total cash flow adds capital investments, operating cash flow before accounting for ΔNWC , and changes in working capital
- Use cash flows, not accounting profits, treat financing separately, and remember the depreciation tax shield
- Only incremental cash flows count, include indirect effects, opportunity costs, working capital, and terminal cash flows, ignore sunk costs

Key Takeaways

- A project's total cash flow adds capital investments, operating cash flow before accounting for ΔNWC , and changes in working capital
- Use cash flows, not accounting profits, treat financing separately, and remember the depreciation tax shield
- Only incremental cash flows count, include indirect effects, opportunity costs, working capital, and terminal cash flows, ignore sunk costs
- Lay the years out in a table, total the cash flows, discount, and apply the NPV rule

Thank you!

Please let me know if you have any questions.