Corporate Finance
公司金融
Week 2
Fundamentals of Capital Budgeting

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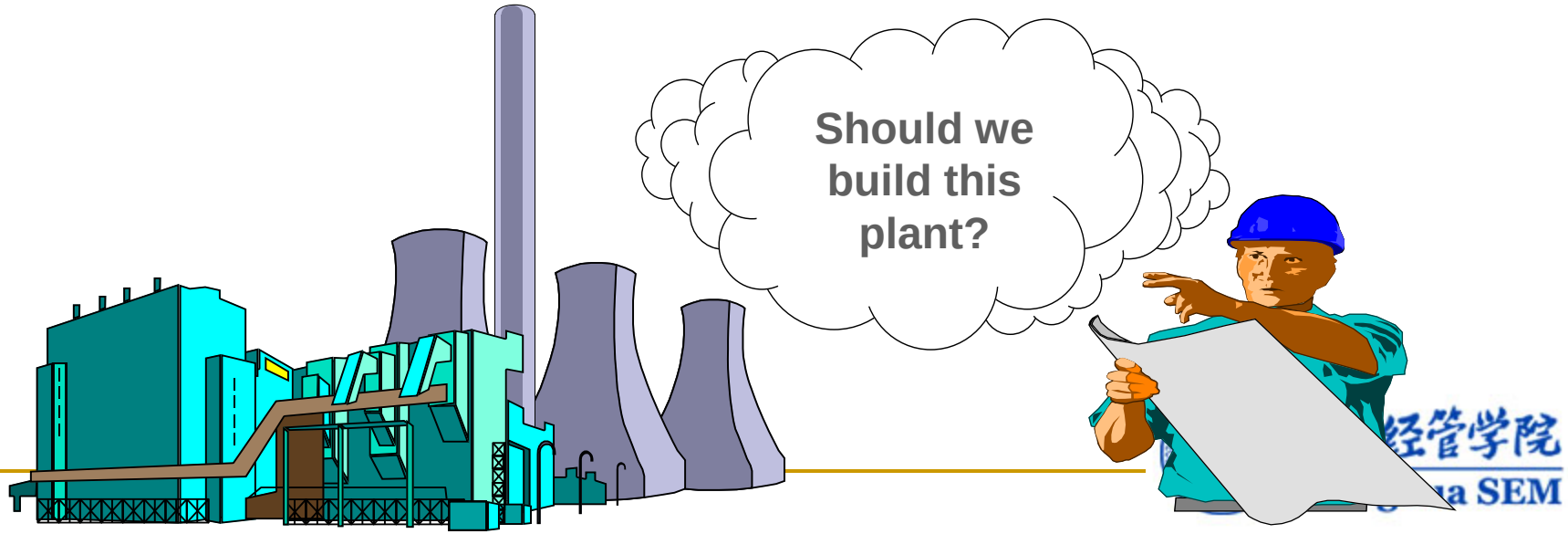
Today's Agenda

1. The Basics of Capital Budgeting
2. Sensitivity Analysis, Scenario Analysis, Break-even Analysis
3. Real Options and Decision Trees



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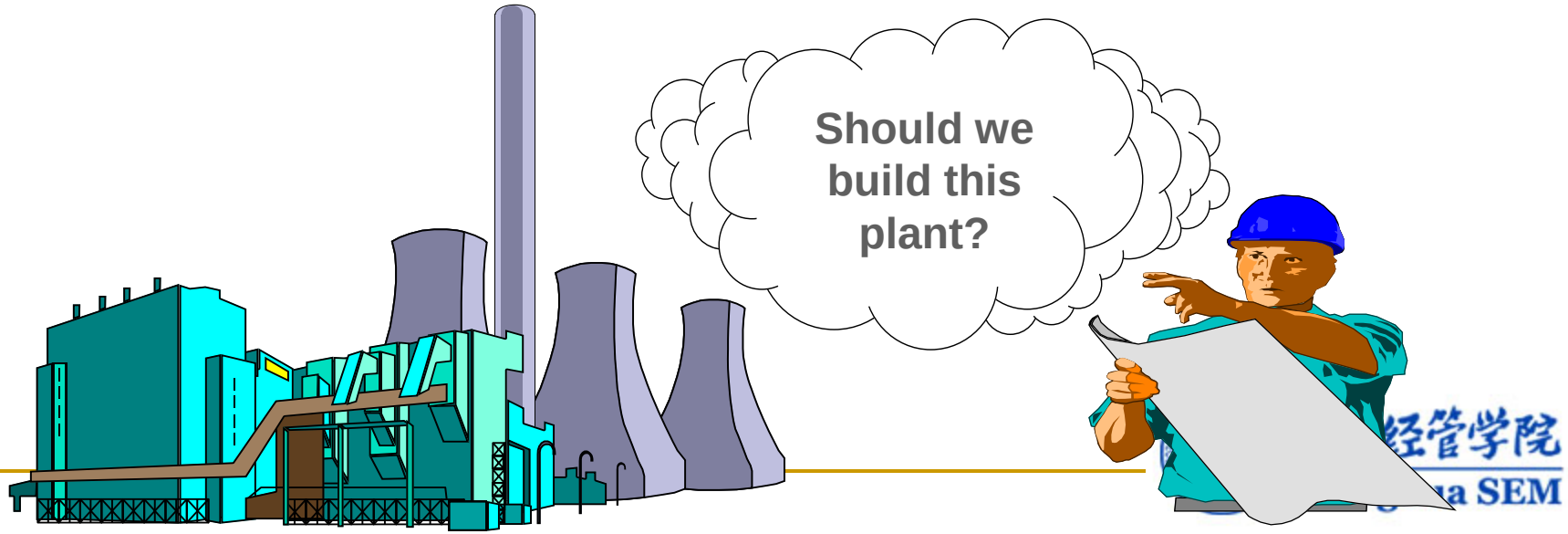

What is Capital Budgeting?

- Capital Budget
  - A *capital budget* lists the projects and investments that a company plans to undertake during the coming year.

- Capital Budgeting
  - It is the process of analyzing investment opportunities and deciding which ones to accept.

- A capital investment project typically has the following two features:
  - Such projects are relatively large
  - A significant period of time (typically more than one year) elapses between the investment outlay and the receipt of the benefits

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What Does Capital Budgeting Entail?

Step 1: Estimate the project's expected *cash flows* by forecasting the project's revenues and costs

Step 2: Compute the project's NPV

Step 3: Compute the sensitivity of the NPV to the uncertainty in the forecasts

Step 4: Make investment decision

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Practical Problem of Capital Budgeting – An Example

- Background Information
  - Linksys is considering the development of a wireless home networking appliance, called **HomeNet**, that will provide both the hardware and the software necessary to run an entire home from any Internet connection.
  - Linksys has already conducted an intensive, $300,000 feasibility study to assess the attractiveness of the new product.

- Revenues and Costs Related Information

  Revenue Related:

  - Based on extensive marketing surveys, the sales forecast for HomeNet is expected to be 100,000 units per year.
  - Sell through distributor with an expected wholesale price of $260.
  - Given the pace of technological change, HomeNet is expected to have a 4-year life span.

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Practical Problem of Capital Budgeting – An Example

Cost Related – Hardware:

- In-house engineering and design costs amount to $5 million (fixed cost)
- Actual production will be outsourced at a cost of $110 per unit (variable cost)

Cost Related – Software:

- In-house software development expenses amount to $10 million
- A testing lab is needed. This lab will occupy existing facilities but will require $7.5 million of new equipment to be depreciated over a 5-year period with zero salvage value, using straight-line depreciation method

Cost Related – Other:

- $2.8 million per year on marketing and support for this product
- Current marginal corporate tax rate is 40%

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What Does Capital Budgeting Entail?

Step 1: Estimate the project's expected *cash flows* by forecasting the project's revenues and costs

Step 2: Compute the project's NPV

Step 3: Compute the sensitivity of the NPV to the uncertainty in the forecasts

Step 4: Make investment decision

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Step 1 (a) : Forecast of Net Income (Revenues and Costs)

	Year	0	1	2	3	4	5
Incremental Earnings Forecast ($000s)							
1	Sales						
2	Cost of Goods Sold						
3	**Gross Profit**						
4	Selling, General, and Administrative						
5	Research and Development						
6	Depreciation						
7	**EBIT**						
8	Income Tax at 40%						
9	**Unlevered Net Income**						

Sales:

- sell 100,000 units/year @ $260 per unit
- Product life span – 4 years

Step 1 (a) : Forecast of Net Income (Revenues and Costs)

	Year	0	1	2	3	4	5
Incremental Earnings Forecast ($000s)							
1	Sales	–	26,000	26,000	26,000	26,000	–
2	Cost of Goods Sold						
3	**Gross Profit**						
4	Selling, General, and Administrative						
5	Research and Development						
6	Depreciation						
7	**EBIT**						
8	Income Tax at 40%						
9	**Unlevered Net Income**						

What goes into COGS?

- In-house engineering and design costs amount to $5 million (fixed cost) ?
- Actual production will be outsourced at a cost of $110 per unit (variable cost) ?

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Step 1 (a) : Forecast of Net Income (Revenues and Costs)

	Year	0	1	2	3	4	5
Incremental Earnings Forecast ($000s)							
1	Sales	–	26,000	26,000	26,000	26,000	–
2	Cost of Goods Sold	–	(11,000)	(11,000)	(11,000)	(11,000)	–
3	**Gross Profit**						
4	Selling, General, and Administrative						
5	Research and Development						
6	Depreciation						
7	**EBIT**						
8	Income Tax at 40%						
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1	Sales	–	26,000	26,000	26,000	26,000	–
2	Cost of Goods Sold	–	(11,000)	(11,000)	(11,000)	(11,000)	–
3	**Gross Profit**	–	15,000	15,000	15,000	15,000	–
4	Selling, General, and Administrative						
5	Research and Development						
6	Depreciation						
7	**EBIT**						
8	Income Tax at 40%						
9	**Unlevered Net Income**						

What goes into SG&A?

- $2.8 million per year on marketing and support of HomeNet

Step 1 (a) : Forecast of Net Income (Revenues and Costs)

	Year	0	1	2	3	4	5
Incremental Earnings Forecast ($000s)							
1	Sales	–	26,000	26,000	26,000	26,000	–
2	Cost of Goods Sold	–	(11,000)	(11,000)	(11,000)	(11,000)	–
3	**Gross Profit**	–	15,000	15,000	15,000	15,000	–
4	Selling, General, and Administrative	–	(2,800)	(2,800)	(2,800)	(2,800)	–
5	Research and Development						
6	Depreciation						
7	**EBIT**						
8	Income Tax at 40%						
9	**Unlevered Net Income**						

What goes into R&D Expense ?

- In-house engineering and design costs amount to $5 million
- In-house software development expenses amount to $10 million

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Step 1 (a) : Forecast of Net Income (Revenues and Costs)

	Year	0	1	2	3	4	5
Incremental Earnings Forecast ($000s)							
1	Sales	–	26,000	26,000	26,000	26,000	–
2	Cost of Goods Sold	–	(11,000)	(11,000)	(11,000)	(11,000)	–
3	**Gross Profit**	–	15,000	15,000	15,000	15,000	–
4	Selling, General, and Administrative	–	(2,800)	(2,800)	(2,800)	(2,800)	–
5	Research and Development	(15,000)	–	–	–	–	–
6	Depreciation						
7	**EBIT**						
8	Income Tax at 40%						
9	**Unlevered Net Income**						

Any Depreciation Expense?

- Testing facilities require $7.5 million of new equipment, depreciated over a 5-year period, with zero salvage value

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Step 1 (a) : Forecast of Net Income (Revenues and Costs)

	Year	0	1	2	3	4	5
Incremental Earnings Forecast ($000s)							
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2	Cost of Goods Sold		–	(11,000)	(11,000)	(11,000)	(11,000)	–
3	**Gross Profit**		–	15,000	15,000	15,000	15,000	–
4	Selling, General, and Administrative		–	(2,800)	(2,800)	(2,800)	(2,800)	–
5	Research and Development		(15,000)	–	–	–	–	–
6	Depreciation		–	(1,500)	(1,500)	(1,500)	(1,500)	(1,500)
7	**EBIT**							
8	Income Tax at 40%							
9	**Unlevered Net Income**							

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2	Cost of Goods Sold		–	(11,000)	(11,000)	(11,000)	(11,000)	–
3	**Gross Profit**		–	15,000	15,000	15,000	15,000	–
4	Selling, General, and Administrative		–	(2,800)	(2,800)	(2,800)	(2,800)	–
5	Research and Development		(15,000)	–	–	–	–	–
6	Depreciation		–	(1,500)	(1,500)	(1,500)	(1,500)	(1,500)
7	**EBIT**		(15,000)	10,700	10,700	10,700	10,700	(1,500)
8	Income Tax at 40%							
9	**Unlevered Net Income**							

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Step 1 (a) : Forecast of Net Income (Revenues and Costs)

	Year	0	1	2	3	4	5
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2	Cost of Goods Sold	–	(11,000)	(11,000)	(11,000)	(11,000)	–
3	**Gross Profit**	–	15,000	15,000	15,000	15,000	–
4	Selling, General, and Administrative	–	(2,800)	(2,800)	(2,800)	(2,800)	–
5	Research and Development	(15,000)	–	–	–	–	–
6	Depreciation	–	(1,500)	(1,500)	(1,500)	(1,500)	(1,500)
7	**EBIT**	(15,000)	10,700	10,700	10,700	10,700	(1,500)
8	Income Tax at 40%	6,000	(4,280)	(4,280)	(4,280)	(4,280)	600
9	**Unlevered Net Income**						

Step 1 (a) : Forecast of Net Income (Revenues and Costs)

	Year	0	1	2	3	4	5
Incremental Earnings Forecast ($000s)							
1	Sales		–	26,000	26,000	26,000	26,000	–
2	Cost of Goods Sold		–	(11,000)	(11,000)	(11,000)	(11,000)	–
3	**Gross Profit**		–	15,000	15,000	15,000	15,000	–
4	Selling, General, and Administrative		–	(2,800)	(2,800)	(2,800)	(2,800)	–
5	Research and Development		(15,000)	–	–	–	–	–
6	Depreciation		–	(1,500)	(1,500)	(1,500)	(1,500)	(1,500)
7	**EBIT**		(15,000)	10,700	10,700	10,700	10,700	(1,500)
8	Income Tax at 40%		6,000	(4,280)	(4,280)	(4,280)	(4,280)	600
9	**Unlevered Net Income**		**(9,000)**	**6,420**	**6,420**	**6,420**	**6,420**	**(900)**

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Step 1 (b) : Forecast the Free Cash Flow (FCF)

- To evaluate a capital budgeting decision, we must determine its consequences for the firm's available cash.
- To calculate FCF, we start from earnings.
- Earnings include non-cash charges, such as depreciation, but do not include the cost of capital investment.
- To calculate FCF, we must adjust for these items.

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The Basic Calculation of FCF

Element	Data Source
Net Income	Current Income Statement
+ Depreciation/Amortization	Current Income Statement
- Changes In Working Capital	Prior & Current Balance Sheets: Current Assets and Liability accounts
- Capital Expenditure	Prior & Current Balance Sheets: Property, Plant and Equipment accounts
= Free Cash Flow	

Net Working Capital (NWC) = Current Assets – Current Liabilities

= Cash + Inventory + Receivables – Payables

To Calculate the Net Working Capital

- Suppose that HomeNet will have no incremental cash or inventory requirements (i.e., products will be shipped directly from the manufacturer to distributors)
- However, HomeNet will create an account receivable = 15% of annual sales
- HomeNet will also create an account payable = 15% of annual COGS

	Year	0	1	2	3	4	5
Net Working Capital Forecast ($000s)							
1	Cash Requirements	–					
2	Inventory	–					
3	Receivables (15% of Sales)	–					
4	Payables (15% of COGS)	–					
5	Net Working Capital	–					

To Calculate the Net Working Capital

- Suppose that HomeNet will have no incremental cash or inventory requirements (i.e., products will be shipped directly from the manufacturer to distributors)
- However, HomeNet will create an account receivable = 15% of annual sales
- HomeNet will also create an account payable = 15% of annual COGS

	Year	0	1	2	3	4	5
Net Working Capital Forecast ($000s)							
1	Cash Requirements	–	–	–	–	–	–
2	Inventory	–	–	–	–	–	–
3	Receivables (15% of Sales)	–	3,900	3,900	3,900	3,900	–
4	Payables (15% of COGS)	–	(1,650)	(1,650)	(1,650)	(1,650)	–
5	Net Working Capital	–	2,250	2,250	2,250	2,250	–

Step 1 (b) : Forecast the Free Cash Flow (FCF)

	Year	0	1	2	3	4	5
Incremental Earnings Forecast ($000s)							
1	Sales	–	26,000	26,000	26,000	26,000	–
2	Cost of Goods Sold	–	(11,000)	(11,000)	(11,000)	(11,000)	–
3	**Gross Profit**	–	15,000	15,000	15,000	15,000	–
4	Selling, General, and Administrative	–	(2,800)	(2,800)	(2,800)	(2,800)	–
5	Research and Development	(15,000)	–	–	–	–	–
6	Depreciation	–	(1,500)	(1,500)	(1,500)	(1,500)	(1,500)
7	**EBIT**	(15,000)	10,700	10,700	10,700	10,700	(1,500)
8	Income Tax at 40%	6,000	(4,280)	(4,280)	(4,280)	(4,280)	600
9	**Unlevered Net Income**	**(9,000)**	**6,420**	**6,420**	**6,420**	**6,420**	**(900)**
Free Cash Flow ($000s)							
10	Plus: Depreciation						
11	Less: Capital Expenditures						
12	Less: Increases in NWC						
13	**Free Cash Flow**						

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Step 1 (b) : Forecast the Free Cash Flow (FCF)

	Year	0	1	2	3	4	5
Incremental Earnings Forecast ($000s)							
1	Sales	–	26,000	26,000	26,000	26,000	–
2	Cost of Goods Sold	–	(11,000)	(11,000)	(11,000)	(11,000)	–
3	**Gross Profit**	–	15,000	15,000	15,000	15,000	–
4	Selling, General, and Administrative	–	(2,800)	(2,800)	(2,800)	(2,800)	–
5	Research and Development	(15,000)	–	–	–	–	–
6	Depreciation	–	(1,500)	(1,500)	(1,500)	(1,500)	(1,500)
7	**EBIT**	(15,000)	10,700	10,700	10,700	10,700	(1,500)
8	Income Tax at 40%	6,000	(4,280)	(4,280)	(4,280)	(4,280)	600
9	**Unlevered Net Income**	**(9,000)**	**6,420**	**6,420**	**6,420**	**6,420**	**(900)**
Free Cash Flow ($000s)							
10	Plus: Depreciation	–	1,500	1,500	1,500	1,500	1,500
11	Less: Capital Expenditures	(7,500)	–	–	–	–	–
12	Less: Increases in NWC	–	(2,250)	–	–	–	2,250
13	**Free Cash Flow**	**(16,500)**	5,670	7,920	7,920	7,920	2,850

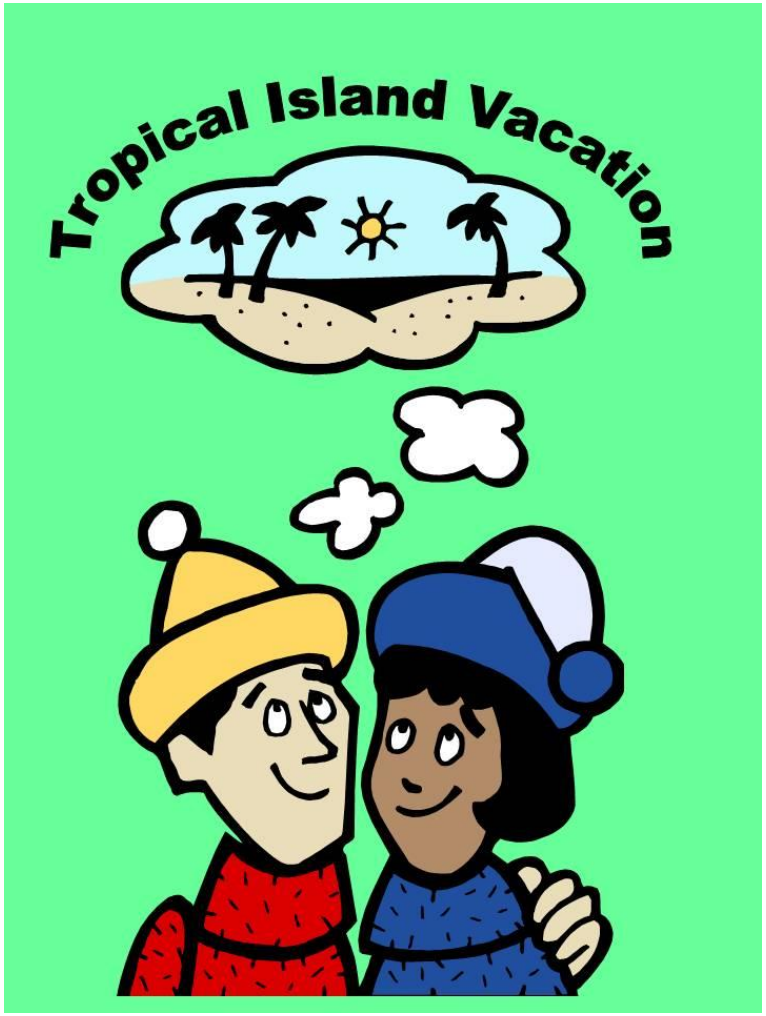
Step 2 : Calculate the Project NPV

Free Cash Flow ($000s)						
10 Plus: Depreciation	–	1,500	1,500	1,500	1,500	1,500
11 Less: Capital Expenditures	(7,500)	–	–	–	–	–
12 Less: Increases in NWC	–	(2,250)	–	–	–	2,250
13 Free Cash Flow	(16,500)	5,670	7,920	7,920	7,920	2,850

- Suppose the cost of capital r = 12%

- **NPV** = -16,500 + 5,670/1.12 + 7,920/(1.12^2) + 7,920/(1.12^3) +
  7,920/(1.12^4) + 2,850/(1.12^5)
  = **7,164 > 0**

Are We Happy Now?



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Any *Indirect* Effects of HomeNet on Incremental Earnings ?

- So far, we have analyzed only the direct effects of the HomeNet project.
- But HomeNet may have indirect consequences for other operations within Linksys.
- When computing the incremental earnings of an investment decision, we should include *all* changes between the firm's earnings with the project vs. without the project.
- Because these indirect effects will also affect company's overall earnings level, we must include them in our analysis.

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Examples of *Indirect* Effects

- Opportunity Costs of Using the Lab
- What Exactly is "Opportunity Cost"?
  - It's an economic term, in contrast to "accounting cost".
  - Scarcity of resources is one of the basic concepts of economics. Scarcity induces trade-offs, and trade-offs result in opportunity costs.
  - **Definition:** The opportunity cost is the value of the next best choice that one gives up when making a decision.
- In the HomeNet Example,
  - It's currently occupying Linksys's facility for free.
  - Suppose HomeNet's lab could have been rented out for $200,000 per year during years 1-4.
  - How does this opportunity cost affect HomeNet's incremental earnings?

Examples of *Indirect* Effects

- Opportunity Costs of Using the Lab

	Year	0	1	2	3	4	5
Incremental Earnings Forecast ($000s)							
1	Sales		–	26,000	26,000	26,000	26,000	–
2	Cost of Goods Sold		–	(11,000)	(11,000)	(11,000)	(11,000)	–
3	**Gross Profit**		–	15,000	15,000	15,000	15,000	–
4	Selling, General, and Administrative		–	(2,800)	(2,800)	(2,800)	(2,800)	–
5	Research and Development		(15,000)	–	–	–	–	–
6	Depreciation		–	(1,500)	(1,500)	(1,500)	(1,500)	(1,500)
7	**EBIT**		(15,000)	10,700	10,700	10,700	10,700	(1,500)
8	Income Tax at 40%		6,000	(4,280)	(4,280)	(4,280)	(4,280)	600
9	**Unlevered Net Income**		**(9,000)**	**6,420**	**6,420**	**6,420**	**6,420**	**(900)**

- It will increase SG&A from $2.8 million to $3.0 million

Examples of *Indirect* Effects

- Project Externalities
  - **Project externalities** are indirect effects of the project that may increase or decrease the profits of other business activities of the firm.
  - When sales of a new product displace sales of an existing product, the situation is often referred to as **cannibalization**.
  - Suppose the introduction of HomeNet will reduce the sale of an existing Linksys router by 25% (currently selling 100,000 units @ $100 per unit, GOGS=$60/unit)
  - How does the externality affect HomeNet's incremental earnings?

Examples of *Indirect* Effects

- Project Externalities

Expected loss in sales of current router = 25% * 100,000 units * $100 / unit = $2.5 million

So the ***incremental revenue*** from HomeNet = $26 million - $2.5 million = $23.5 million

Expected reduction in COGS of router = 25% * 100,000 units * $60 /unit = $1.5 million

So the ***incremental COGS*** from HomeNet = $11 million – $1.5 million = $9.5 million

What about the $300,000 Costs on Feasibility Study?

- The feasibility study is a **Sunk Cost**
- Sunk cost is any unrecoverable cost for which the firm is already liable.
- In other word, sunk costs have been or will be paid regardless of the decision whether or not to proceed with the project.
- Therefore, they are not incremental with respect to the current decision and should ***NOT*** be included in the investment decision analysis.

The Income Statement Now Looks Like..

	Year	0	1	2	3	4	5
Incremental Earnings Forecast ($000s)							
1	Sales	–	23,500	23,500	23,500	23,500	–
2	Cost of Goods Sold	–	(9,500)	(9,500)	(9,500)	(9,500)	–
3	**Gross Profit**	–	14,000	14,000	14,000	14,000	–
4	Selling, General, and Administrative	–	(3,000)	(3,000)	(3,000)	(3,000)	–
5	Research and Development	(15,000)	–	–	–	–	–
6	Depreciation	–	(1,500)	(1,500)	(1,500)	(1,500)	(1,500)
7	**EBIT**	(15,000)	9,500	9,500	9,500	9,500	(1,500)
8	Income Tax at 40%	6,000	(3,800)	(3,800)	(3,800)	(3,800)	600
9	**Unlevered Net Income**	**(9,000)**	**5,700**	**5,700**	**5,700**	**5,700**	**(900)**

Recalculate the Net Working Capital

	Year	0	1	2	3	4	5
Net Working Capital Forecast ($000s)							
1	Cash Requirements	–	–	–	–	–	–
2	Inventory	–	–	–	–	–	–
3	Receivables (15% of Sales)	–	3,525	3,525	3,525	3,525	–
4	Payables (15% of COGS)	–	(1,425)	(1,425)	(1,425)	(1,425)	–
5	Net Working Capital	–	2,100	2,100	2,100	2,100	–

Recalculate the Free Cash Flow

	Year	0	1	2	3	4	5
Incremental Earnings Forecast ($000s)							
1	Sales	–	23,500	23,500	23,500	23,500	–
2	Cost of Goods Sold	–	(9,500)	(9,500)	(9,500)	(9,500)	–
3	**Gross Profit**	–	14,000	14,000	14,000	14,000	–
4	Selling, General, and Administrative	–	(3,000)	(3,000)	(3,000)	(3,000)	–
5	Research and Development	(15,000)	–	–	–	–	–
6	Depreciation	–	(1,500)	(1,500)	(1,500)	(1,500)	(1,500)
7	**EBIT**	(15,000)	9,500	9,500	9,500	9,500	(1,500)
8	Income Tax at 40%	6,000	(3,800)	(3,800)	(3,800)	(3,800)	600
9	**Unlevered Net Income**	**(9,000)**	**5,700**	**5,700**	**5,700**	**5,700**	**(900)**
Free Cash Flow ($000s)							
10	Plus: Depreciation	–	1,500	1,500	1,500	1,500	1,500
11	Less: Capital Expenditures	(7,500)	–	–	–	–	–
12	Less: Increases in NWC	–	(2,100)	–	–	–	2,100
13	**Free Cash Flow**	**(16,500)**	**5,100**	**7,200**	**7,200**	**7,200**	**2,700**

Recalculate the NPV

		Year	0	1	2	3	4	5
Net Present Value ($000s)								
1	Free Cash Flow		(16,500)	5,100	7,200	7,200	7,200	2,700
2	Project Cost of Capital	12%						
3	Discount Factor		1.000	0.893	0.797	0.712	0.636	0.567
4	PV of Free Cash Flow		(16,500)	4,554	5,740	5,125	4,576	1.532
5	NPV		5,027					

In-Class Exercise: Evaluating Manufacturing Alternatives

- Suppose Linksys is considering an alternative manufacturing plan for the HomeNet product

- The currently plan is to fully outsource production at a cost of $110 per unit. Alternatively, Linksys could assemble the product in-house at a cost of $95 per unit

- However, the latter option will require

  (1) an additional $5 million in upfront in R&D

  (2) maintain inventory equal to one month's production (without taking into account the externality effect)

- Calculate the FCF for each year

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Original Free Cash Flow

	Year	0	1	2	3	4	5
Incremental Earnings Forecast ($000s)							
1	Sales		–	23,500	23,500	23,500	–
2	Cost of Goods Sold		–	(9,500)	(9,500)	(9,500)	–
3	**Gross Profit**		–	14,000	14,000	14,000	–
4	Selling, General, and Administrative		–	(3,000)	(3,000)	(3,000)	–
5	Research and Development		(15,000)	–	–	–	–
6	Depreciation		–	(1,500)	(1,500)	(1,500)	(1,500)
7	**EBIT**		(15,000)	9,500	9,500	9,500	(1,500)
8	Income Tax at 40%		6,000	(3,800)	(3,800)	(3,800)	600
9	**Unlevered Net Income**		**(9,000)**	**5,700**	**5,700**	**5,700**	**(900)**
Free Cash Flow ($000s)							
10	Plus: Depreciation		–	1,500	1,500	1,500	1,500
11	Less: Capital Expenditures		(7,500)	–	–	–	–
12	Less: Increases in NWC		–	(2,100)	–	–	2,100
13	**Free Cash Flow**		**(16,500)**	**5,100**	**7,200**	**7,200**	**2,700**

What is the New FCF ?

	Year	0	1	2	3	4	5
Incremental Earnings Forecast ($000s)							
1	Sales	–	23,500	23,500	23,500	23,500	–
2	Cost of Goods Sold	–	(8,000)	(8,000)	(8,000)	(8,000)	–
3	Gross Profit	–	15,500	15,500	15,500	15,500	–
4	Selling, General, and Administrative	–	(3,000)	(3,000)	(3,000)	(3,000)	–
5	Research and Development	(20,000)	–	–	–	–	–
6	Depreciation		(1,500)	(1,500)	(1,500)	(1,500)	(1,500)
7	EBIT	(20,000)	11,000	11,000	11,000	11,000	(1,500)
8	Income Tax at 40%	8,000	(4,400)	(4,400)	(4,400)	(4,400)	600
9	Unlevered Net Income	(12,000)	6,600	6,600	6,600	6,600	(900)
Free Cash Flow ($000s)							
10	Plus: Depreciation	–	1,500	1,500	1,500	1,500	1,500
11	Less: Capital Expenditures	(7,500)	–	–	–	–	–
12	Less: Increases in NWC	–	(3,117)	–	–	–	3,117
13	Free Cash Flow	(19,500)	4,983	8,100	8,100	8,100	3,717

What is the New FCF ?

	Year	0	1	2	3	4	5
Net Working Capital Forecast ($000s)							
1	Cash Requirements	–	–	–	–	–	–
2	Inventory	–	792	792	792	792	–
3	Receivables (15% of Sales)	–	3,525	3,525	3,525	3,525	–
4	Payables (15% of COGS)	–	(1,200)	(1,200)	(1,200)	(1,200)	–
5	Net Working Capital	–	3,117	3,117	3,117	3,117	–

- Inventory = $9.5 million /12 = $0.792 million
- Payable = 15% * $8 million = $1.2 million

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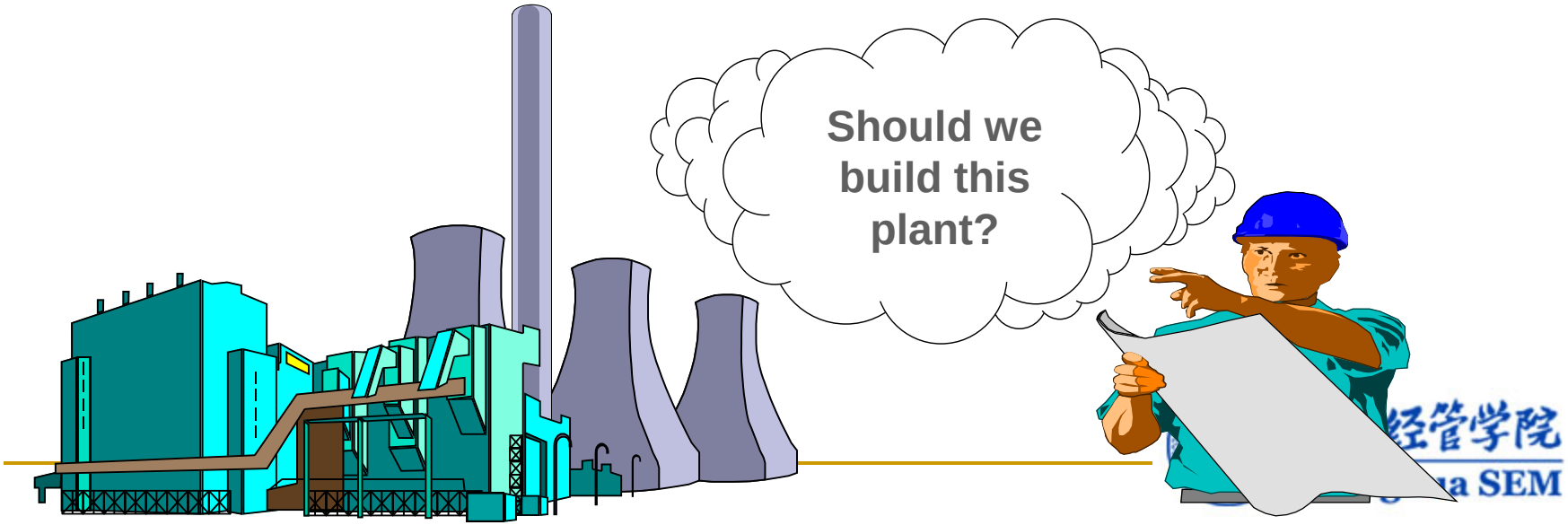
Today's Agenda

1. The Basics of Capital Budgeting

2. Sensitivity Analysis, Scenario Analysis, Break-even Analysis

3. Real Options and Decision Trees



What Does Capital Budgeting Entail?

Step 1: Estimate the project's expected *cash flows* by forecasting the project's revenues and costs

Step 2: Compute the project's NPV

Step 3: Compute the sensitivity of the NPV to the uncertainty in the forecasts

Step 4: Make investment decision

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Step 3: Analyzing the Project

- The most challenging part of capital budgeting is how to accurately estimate the cash flows and the cost of capital
- These estimates are often subject to significant uncertainty
- So we need to analyze how sensitive our results are with respect to the set of forecast assumptions / estimates
- Three common methods are:
  (1) Break-even analysis
  (2) Sensitivity analysis
  (3) Scenario analysis

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Break-Even Analysis

- When we are uncertain regarding the input to a capital budgeting decision, it is often useful to determine the break-even level of that input, which is the level for which the investment has a zero NPV.

- We can do this for every input variable (parameter)

Parameter	Break-Even Level
Units sold	79,759 units per year
Wholesale price	$232 per unit
Cost of goods	$138 per unit
Cost of capital	24.1%

- We could also compute other break-even benchmarks (e.g., EBIT break-even for sales)

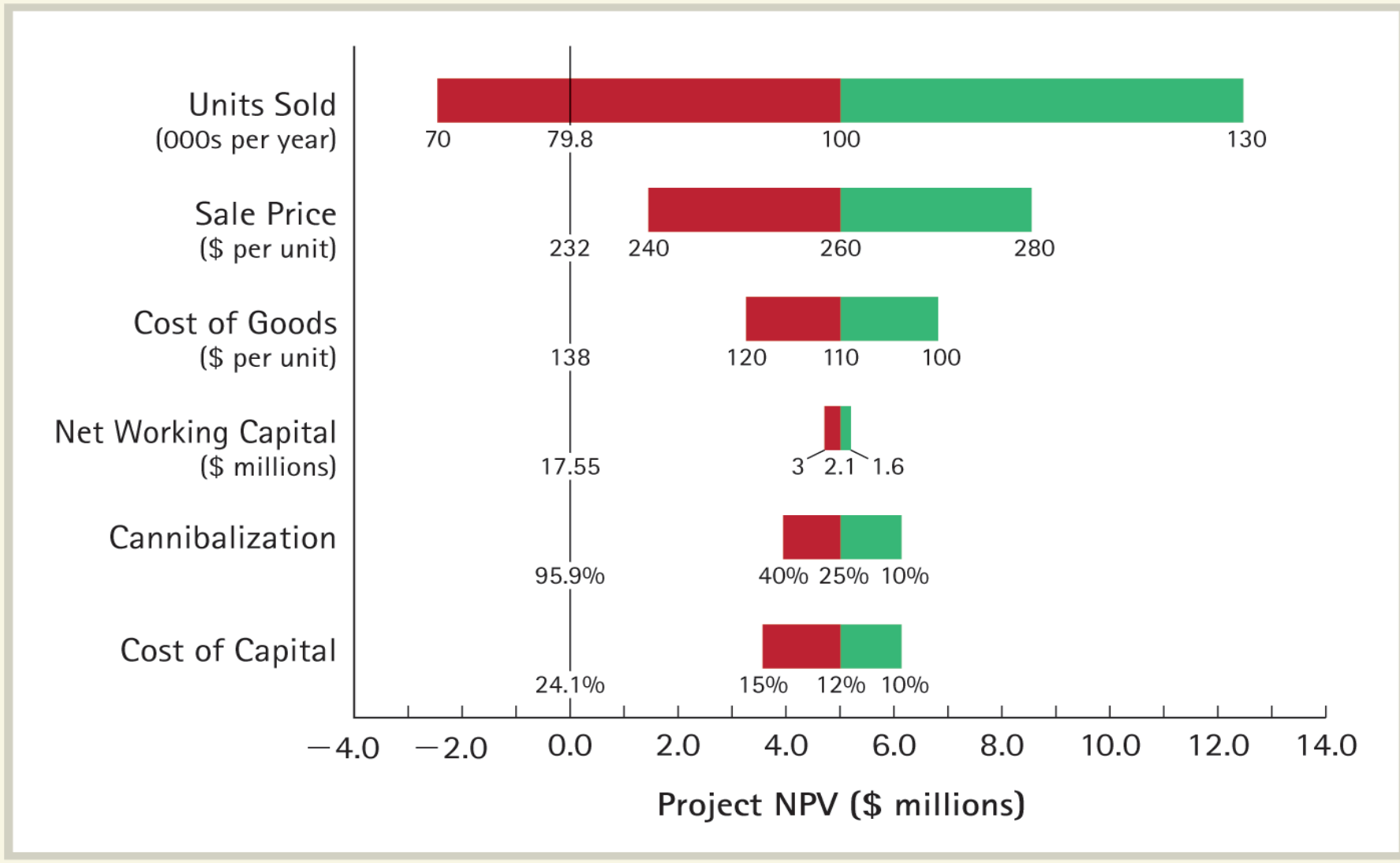
Sensitivity Analysis

- Breaks the NPV calculation into its component assumptions and shows how the NPV varies as the underlying assumptions change.
- It allows us to explore the effects of errors in our NPV estimates for the project.
- By conducting a sensitivity analysis, we learn which assumptions are the most important. We can then invest further resources and effort to refine these assumptions. Such an analysis also reveals which aspects of the project are most critical.
- To undertake a sensitivity analysis, we set each key input variable in turn at its most pessimistic or optimistic value and recalculate the NPV of the project.

Sensitivity Analysis – HomeNet Example

Parameter	Initial Assumption	Worst Case	Best Case
Units sold (thousands)	100	70	130
Sale price ($/unit)	260	240	280
Cost of goods ($/unit)	110	120	100
NWC ($ thousands)	2100	3000	1600
Cannibalization	25%	40%	10%
Cost of capital	12%	15%	10%

HomeNet's NPV Under Best- and Worst-Case



Sensitivity Analysis – Limitations

- It tends to give ambiguous results. For example, what exactly does optimistic (best-case) or pessimistic (worst-case) mean?
- The underlying variables are likely to be interrelated. For example, an increase in sales is an indicator of higher market demand, leading to a potentially higher price?
- Hard to push the one-at-a-time sensitivity analysis too far.

Scenario Analysis

- Scenario analysis allows us to look at different but consistent combinations of variables.

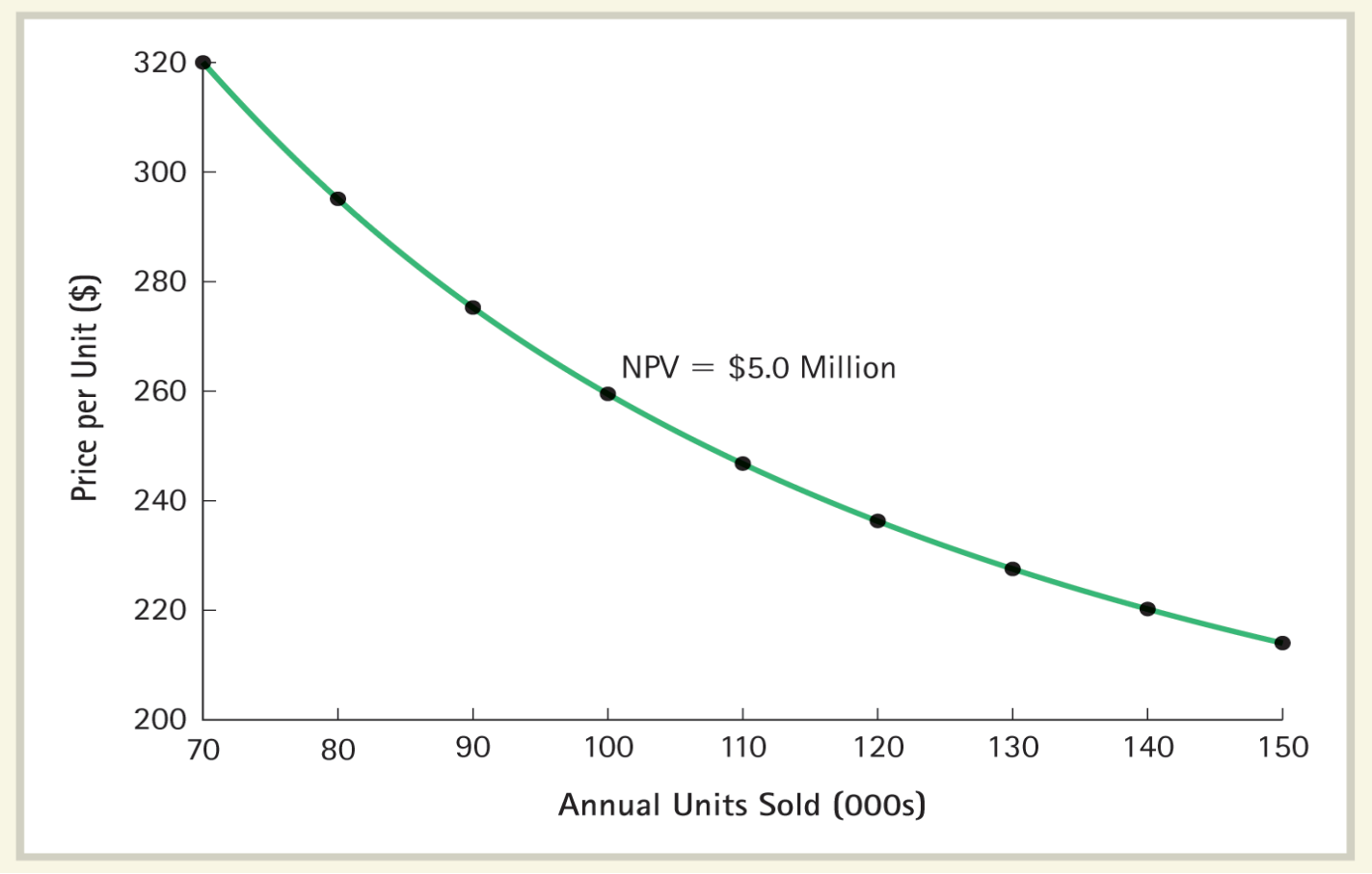
- It considers the effect on NPV of changing multiple project parameters.

- For example, lowering HomeNet's price may increase the number of units sold.

Strategy	Sale Price ($/unit)	Expected Units Sold (thousands)	NPV ($ thousands)
Current strategy	260	100	5027
Price reduction	245	110	4582
Price increase	275	90	4937

Price and Volume Combinations for HomeNet with Equivalent NPV

The graph shows alternative price per unit and annual volume combinations that lead to an NPV of $5.0 million. Pricing strategies with combinations above this line will lead to a higher NPV and are superior.



Things to Watch Out in Capital Budgeting

- As the company CFO, you receive thousands of requests for funds for capital expenditures everyday from various departments.
- All these requests are supported with detailed analyses showing that the projects have positive NPVs.
- How, then, can you distinguish the NPVs that are truly positive from those that are merely the result of either unintentional forecasting errors (i.e., over/under estimates) or intentional forecasting errors (i.e., the numbers are being crunched and manipulated on purpose?)

Strategy, Strategy, Strategy !

- NPV analysis is nothing but a financial tool, strategy is core !
- Good strategy positions the firm to generate the most value from its assets and growth opportunities.
- To make good investment decisions, you need to understand your company's competitive advantages and sustainable sources of economic gain. Does the set of input assumptions make sense?
- Look at the environment you are competing in, who are your enemies? who are your friends? how can you differentiate yourself from others?

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To Earn Sustainable Economic Rents…

- **Michael Porter**, a famous strategy professor at Harvard, identifies sources of sustained economic rents both at the industry level and at the firm level.
- Firms can generate economic rents both by their choice of industry and by the way that they position themselves within that industry.
- At the industry level
  - Rivalry among existing competitors
  - Likelihood of new competition
  - Threat of substitutes
  - Bargaining power of suppliers
  - Bargaining power of customers
- At the firm level
  - Cost leadership
  - Product differentiation
  - Focus on a particular market niche

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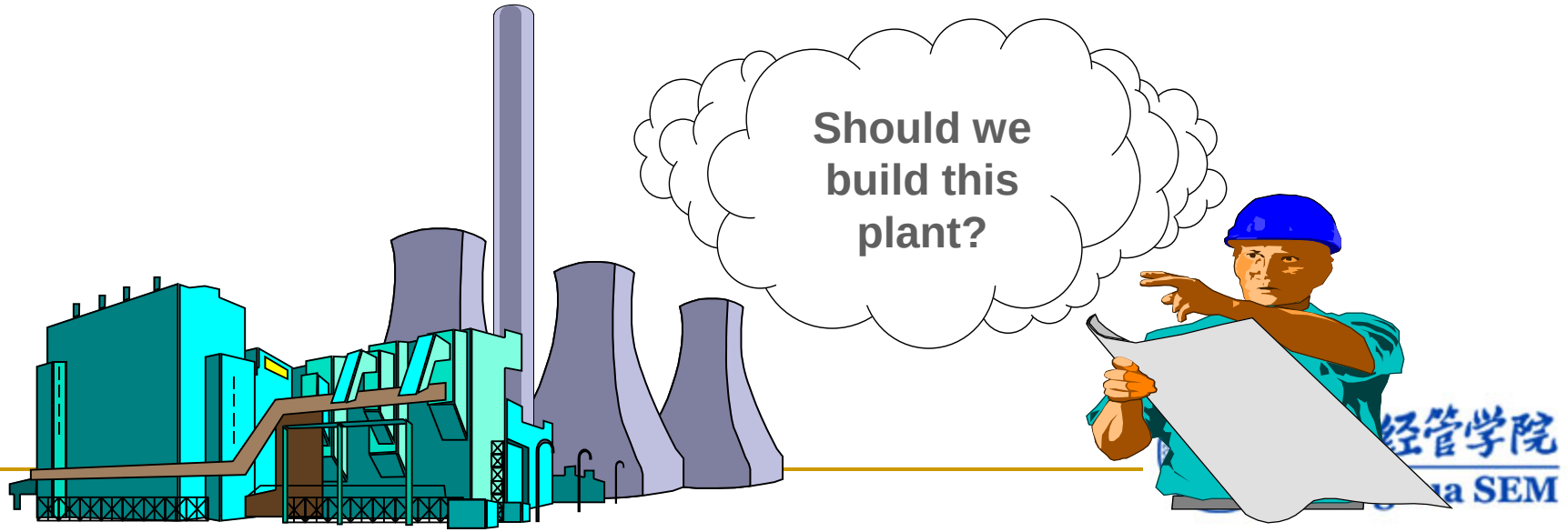

Real Options

- Once the investment decision is made, is this the end of the story?
- No
- Managers still have the options to modify the project
  → **Real Options**
- If things go well, the project may be expanded; if they go sour, the project may be cut back or abandoned altogether
- Note that none of the break-even, sensitivity, or scenario analyses recognizes the opportunity to modify projects

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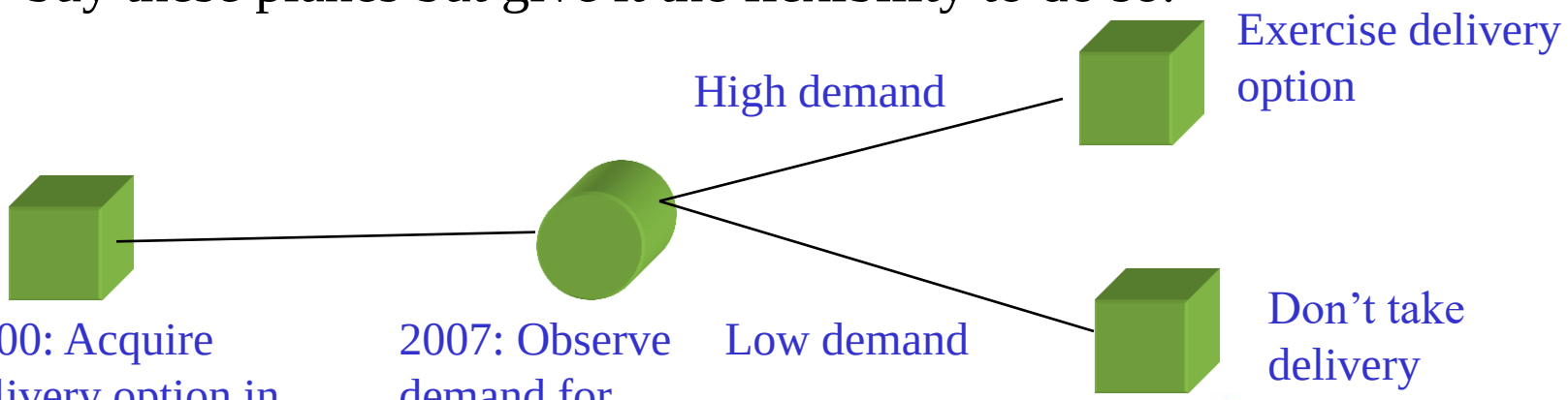
A Simple Example of Real Option

- In 2000, UPS wanted to place an order for 10 Airbus superjumbo transport planes from Boeing to be delivered in the years 2008-2011.
- However, UPS wasn't 100% sure if these additional planes are needed.
- So instead, UPS acquired an option to buy 10 planes at a predetermined price. This option does not commit the company to buy these planes but give it the flexibility to do so.

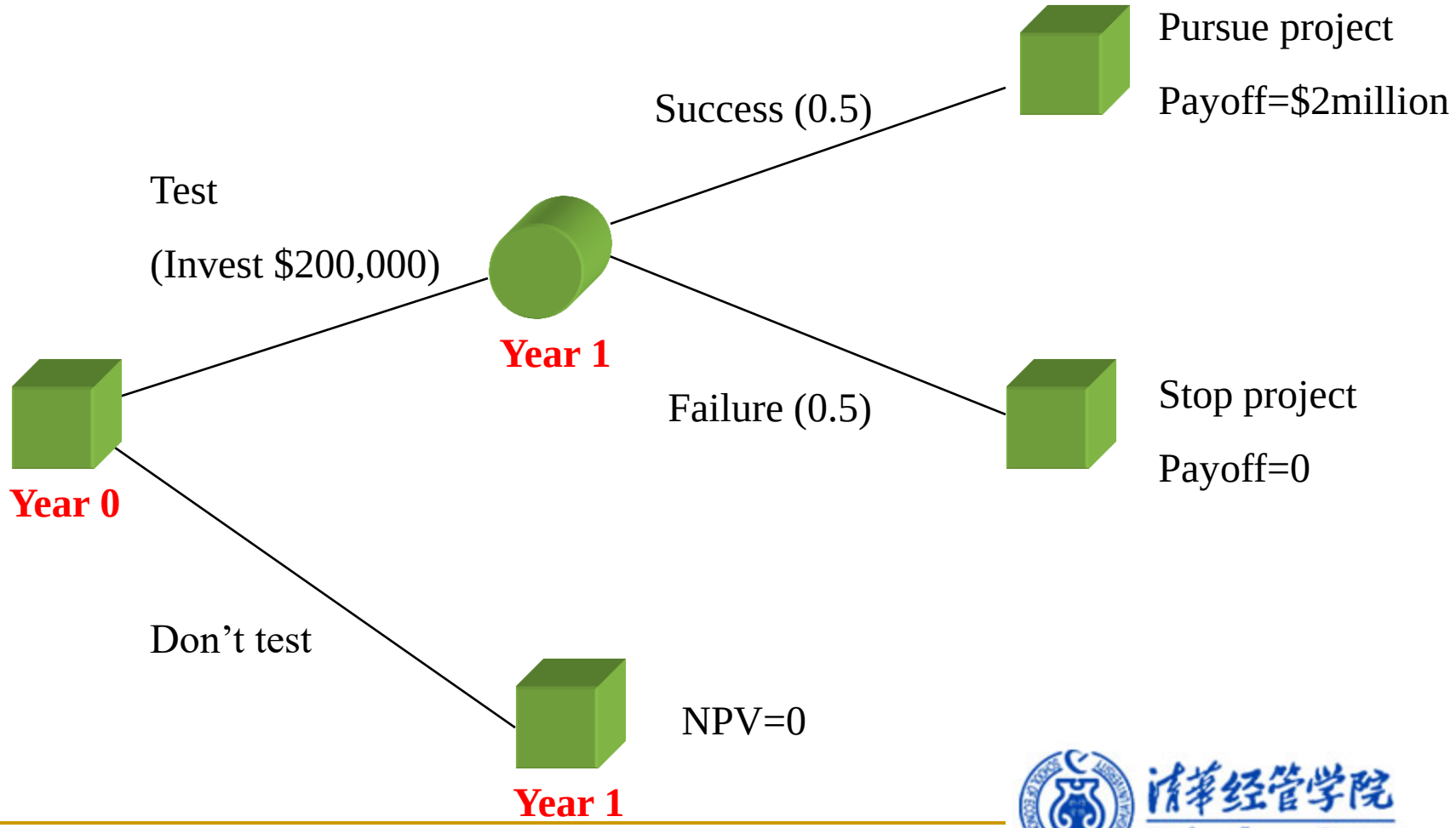


Decision Trees

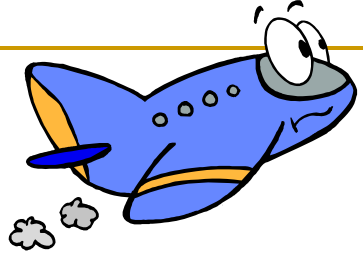
- Decision trees are commonly used to describe the real options imbedded in capital investment projects
- They help answer the question: to be or not to be
- Extensively used in game theories, dynamic programming etc.
- Visual and Logical - a picture is worth a thousand words
- Key to solve the decision tree is the notion of "reverse-engineering" i.e., start from the end and work backwards in time (sequential decision)

Decision Trees – A Simple Investment Example

- Suppose the interest rate is 10%, should we test it?



In- Class Exercise: Fly the Boss, Inc.



- You are thinking about starting a flying service for the business executives in China. You believe there will be a ready demand from businesses that cannot justify a full-time corporate jet for the boss but nevertheless need one from time to time.
- There is 40% chance that demand in the first year will be low. If it is low, there is a 60% chance that it will remain low in subsequent years.
- On the other hand, if the initial demand is high, there is a 80% chance that it will stay high. Cost of capital = 10%
- You immediate problem is to decide what kind of plane to buy.
  - A *turboprop* costs $550,000
  - A *piston-engine plane* costs only $250,000 but has less capacity and customer appeal. It also depreciates rapidly. If demand is high, you can choose to get another one next year for $150,000

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