Chapter 9

Project Analysis

Topics Covered

- How Firms Organize the Investment Process
- Some “what if” Questions
  - Sensitivity Analysis
  - Scenario Analysis
- Break Even Analysis
- Real Options and the Value of Flexibility

Capital Budgeting Process

Capital Budget - The list of planned investment projects.

The Decision Process

1. Develop and rank all investment projects
   - Capital Budget (bottom-up) and Strategic Planning (top-down)
2. Authorize projects based on different categories of projects
   - Government regulation (e.g. pollution control project)
   - Maintenance or cost reduction (e.g. machine replacement)
   - Capacity expansion
   - Investment for new products (depending on strategic decisions)

Capital Budgeting Process

- Capital Budgeting Problems
  - Consistent forecasts
    - Different divisions may have different prospect
    - Establishing forecast of economic indicators centrally
  - Conflict of interest
    - Agency problem (managers vs. stockholders)
  - Forecast bias
    - Over-optimism is a common feature in financial forecasts, for instance, large public expenditure proposals
    - Politics inside the firm

Capital Budgeting Process

➔Selection criteria (NPV and others)

- Impose capital rationing to force the subunits to choose good projects
- Positive NPVs are plausible only if your compnay has some competitive advantage (e.g., first-entrant advantage, proprietary technology, lower-cost advantage, reputation, etc.)

How To Handle Uncertainty

Sensitivity Analysis - Analysis of the effects of changes in sales, costs, etc. on a project.

Scenario Analysis - Project analysis given a particular combination of assumptions.

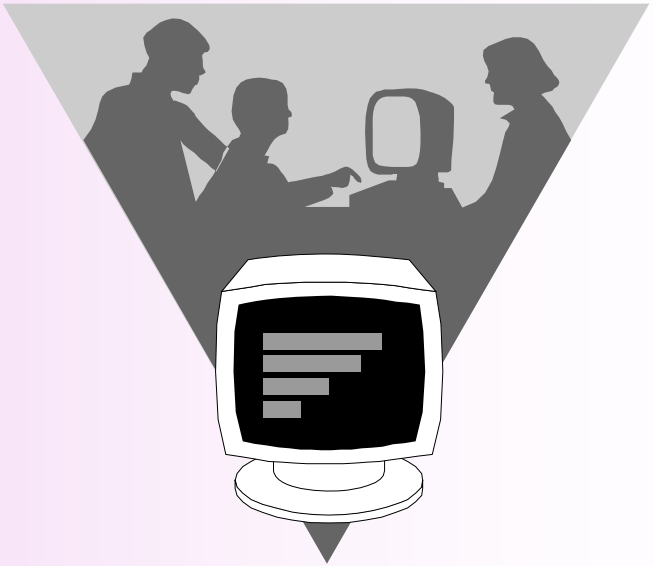
Simulation Analysis - Estimation of the distribution of different possible outcomes.

Break Even Analysis - Analysis of the level of sales (or other variable) at which the company breaks even.

Sensitivity Analysis

Example

Given the expected cash flow forecasts for future 12 years listed on the next slide, determine the NPV of the project given changes in the cash flow components using an 8% cost of capital. Assume that all variables remain constant, except the one you are changing.



Sensitivity Analysis

Example – continued (,000s)

	Year 0	Years 1 - 12
Investment	- 5,400	
Sales		16,000
Variable Costs		13,000
Fixed Costs		2,000
Depreciation		450
Pretax profit		550
.Taxes @ 40%		220
Profit after tax		330
Operating cash flow		780
Net Cash Flow	- 5,400	780

NPV= $478

Sensitivity Analysis

Example - continued

Possible Outcomes

	Range		
Variable	*Pessimistic*	*Expected*	*Optimistic*
Investment (000s)	6,200	5,400	5,000
Sales (000s)	14,000	16,000	18,000
Var Cost (% of sales)	83%	81.25%	80%
Fixed Costs (000s)	2,100	2,000	1,900

Sensitivity Analysis

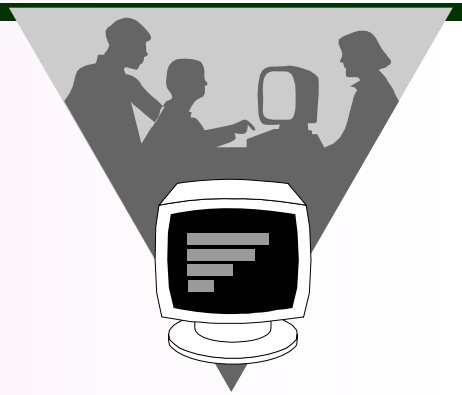
Example - continued

NPV Calculations for Pessimistic Investment Scenario

	Year 0	Years 1 - 12
Investment	- 6,200	
Sales		16,000
Variable Costs		13,000
Fixed Costs		2,000
Depreciation		450
Pretax profit		550
.Taxes @ 40%		220
Profit after tax		330
Operating cash flow		780
Net Cash Flow	- 6,200	780

NPV= ($121)

Sensitivity Analysis



Example - continued

NPV Possibilities ***(change one variable at a time)***

	NPV (000*s*)		
Variable	*Pessimistic*	*Expected*	*Optimistic*
Investment(000s)	-121	478	778
Sales(000s)	-1,218	478	2,174
Var Cost (% of sales)	- 788	478	1,382
Fixed Costs(000s)	26	478	930

Sensitivity Analysis

- Information retrieved
  - Estimation of sales seems to have a great impact on NVP, and therefore additional survey data may be needed
  - Changes of fixed costs seems less important
- Limits of sensitivity analysis
  - Sensitivity analysis gives ambiguous results (What does optimistic or pessimistic mean?)
  - The underlying variables are assumed to be independent (So the changes of the underlying cannot be pushed too far)

Scenario Analysis

Example - continued

Cash Flows (years 1-12)

	Base Case.	Competing Store Scenario.
1. Sales	16,000,000	13,600,000
2. Variable costs	13,000,000	11,152,000
3.Fixed costs	2,000,000	2,000,000
4. Depreciation	450,000	450,000
5. Pretax profit (1 - 2 - 3 - 4)	550,000	- 2,000
6.Taxes	220,000	- 800
7. Profit after tax	330,000	-1,200
8.Cash flow from operations (4 + 7)	780,000	448,000
Present value of cash flows	5,878,000	3,382,000
NPV	478,000	- 2,018,000

Simulation Analysis

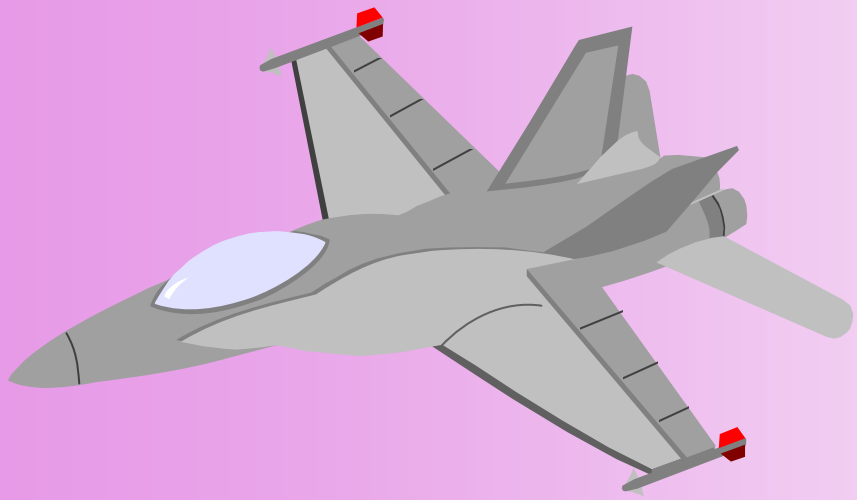
- Simulation analysis is an extension of scenario analysis
- Instead of arbitrarily specifying a relatively small number of scenarios, a computer generates several thousand possible combinations of variables via probability distributions according to the historical data
- The entire probability distribution of outcomes can be constructed from the simulation results

Break Even Analysis

- Sales volume is usually taken as the analyzed variable
- The definitions of “break-even”:

1. Accounting-Based Break-Even Analysis
   - A project that breaks even gives you your investment back
   - It does not cover the opportunity cost of the capital (initial investment) (p.247 table 9-4 and figure 9-1)
2. NPV-Based (or Economic) Break-Even Analysis
   - It is more properly because the opportunity cost of the capital is taken into consideration
   - The NPV at the economic break-even point is zero

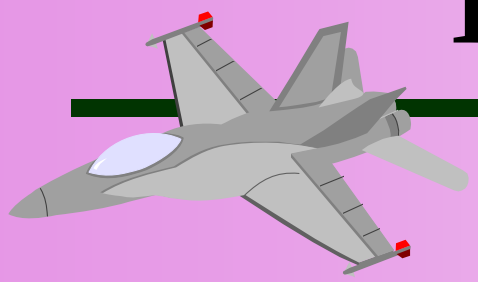
Break Even Analysis



Example

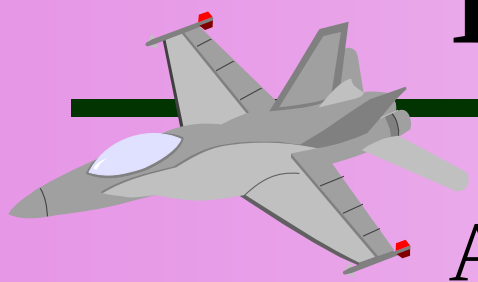
Given the forecasted data on the next slide, determine the number of planes that the company must produce in order to break even, on an NPV basis. The company's cost of capital is 10%.

Break Even Analysis



	Year 0	Years 1 - 6
Investment	$900	
Sales		15.5x Planes Sold
Var. Cost		8.5x Planes Sold
Fixed Costs		175
Depreciation		900/6 = 150
Pretax Profit		(7x Planes Sold) - 325
Taxes (50%)		(3.5x Planes Sold) - 162.5
Net Profit		(3.5x Planes Sold) - 162.5
Net Cash Flow	- 900	(3.5x Planes Sold) - 12.5 = (3.5x Planes Sold) - 162.5 + 150

Break Even Analysis



Answer

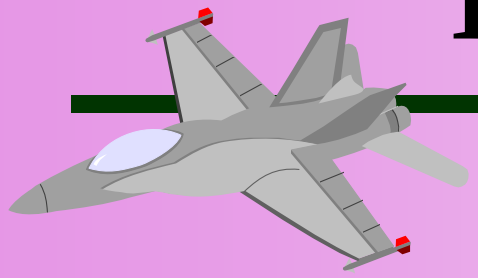
The break even point, is the # of Planes sold that generates a NPV=$0.

The present value annuity factor of a 6 year cash flow at 10% is 4.355

Thus,

$$NPV = -900 + 4.355\,(3.5 \text{ x Planes Sold} - 12.5)$$

Break Even Analysis



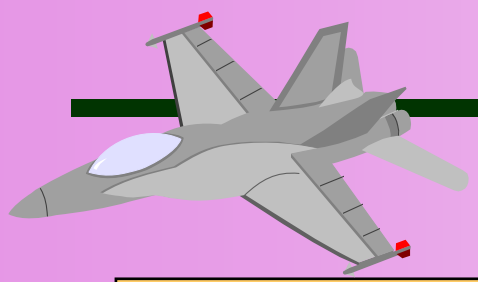
Answer

Solving for “Planes Sold”

$$0 = -900 + 4.355\,(3.5\text{x}\text{Planes Sold} - 12.5)$$

$$\Rightarrow \text{Planes Sold} = 63$$

EVA & Break Even



EVA = accounting profit – additional cost of capital = 0

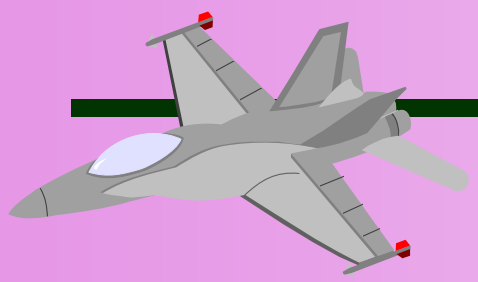
($3.5 x planes sold - $162.50) - $56.6 = 0

=>Planes sold = 219.1 / 3.5 = 62.6

* Economic value added (EVA): Income that is measured after deduction of the cost of capital

* The equivalent annual annuity of the capital invested in the project is 900/4.355 = 206.6. That is 56.6 more than the allowance for annual depreciation 150

EVA & Break Even



➲ Another example

1. Variable costs	81.25 percent of sales
2. Fixed costs	$2 million
3. Depreciation	$450,000
4. Pretax profit	(.1875 x sales) - $2.45 million
5. Tax (as 40%)	.40 x (.1875 x sales - $2.45 millions)
6. After - tax accounting profit	.60 x (.1875 x sales - $2.45 millions)
7. Cost of capital over and above allowed depreciation	$266,553
8. Economic Value Added (= line 6 - line 7)	.60 x (.1875 x sales - $2.45 millions) - $266,553

➔ After-tax account profit is zero => sales = $13.06 million

➔ Economic value added is zero => sales = $15.44 million

(p.249) (比較p.247 Figure 9-1與p.250 Figure 9-2)

Operating Leverage

Operating Leverage - The degree to which costs are fixed. (fixed costs所佔的比重)

Degree of Operating Leverage (DOL) - Percentage change in profits given a 1 percent change in sales.

$$DOL = \frac{\%\ \text{change in profits}}{\%\ \text{change in sales}}$$

(high fixed costs => high operating leverage => magnify the variation in profits due to the variation in sales)

Operating Leverage

Example - A company has sales outcomes that range from $16mil to $19 mil, depending on the economy. The same conditions can produce profits in the range from $550,000 to $1,112,000. What is the DOL?

$$DOL = \frac{102.2}{18.75} = 5.45$$

What is the DOL if the profits are from $550,000 to $1,030,000?

$$DOL = \frac{87.3}{18.75} = 4.65$$

(compare the results in p.252 table 9-6)

Operating Leverage

$$\text{DOL} = \frac{\%\ \text{change in profits}}{\%\ \text{change in sales}} \overset{\text{sale}\uparrow 1\%}{=} \frac{\text{change in profits/level of profits}}{0.01}$$

$$= 100 \times \frac{\text{change in profits}}{\text{level of profits}} = 100 \times \frac{0.01 \times (\text{sales - variable costs})}{\text{level of profits}}$$

$$= 100 \times \frac{0.01 \times (\text{profits} + \text{fixed costs})}{\text{level of profits}} = 1 + \frac{\text{fixed costs}}{\text{level of profits}}$$

Flexibility & Real Options

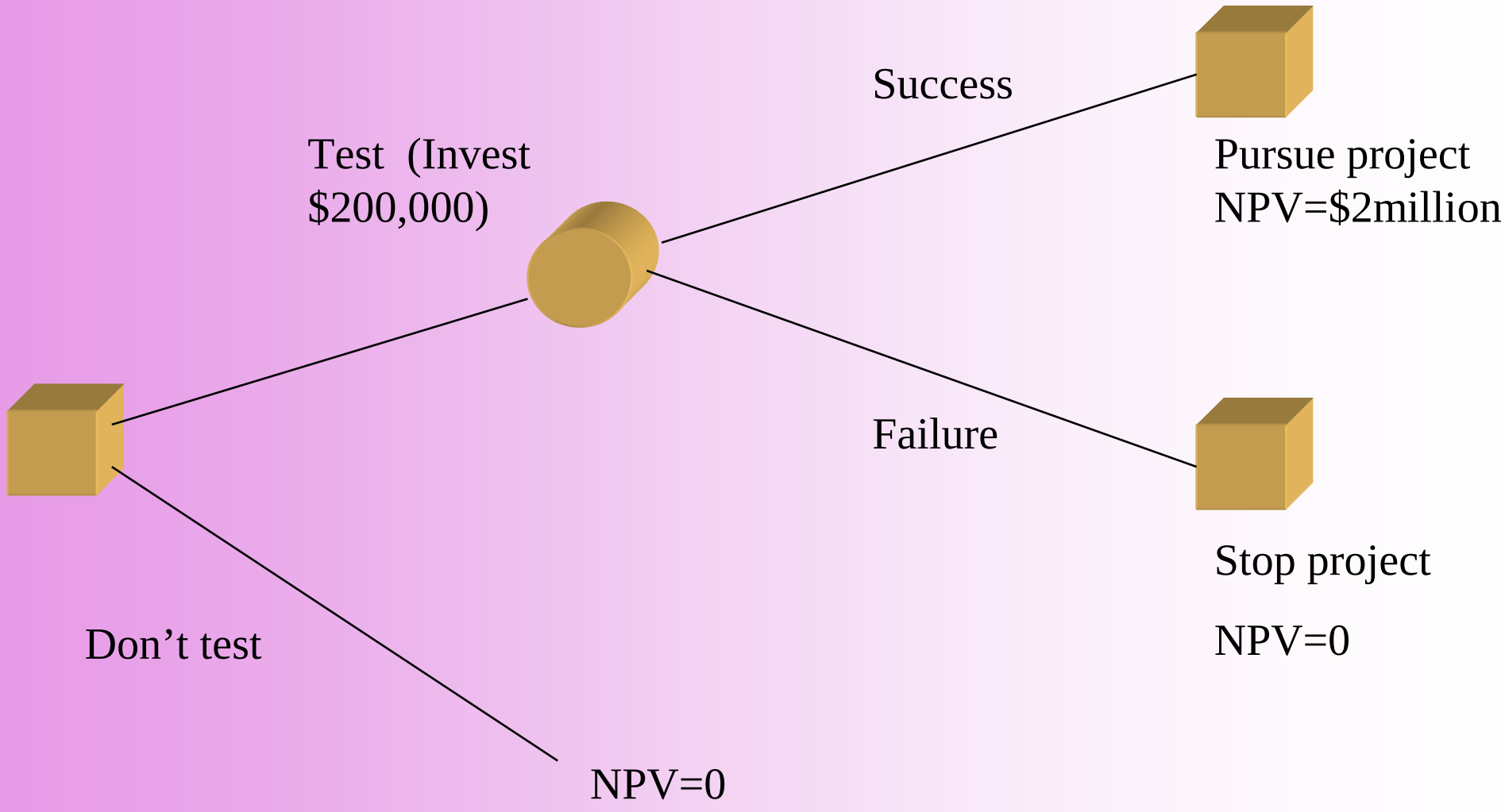
- When you use DCF to value a project, you implicitly assume the firm will hold the project passively
- However, the real world is that if things go will, the project may be expanded; if they go badly, the project may be cut back or abandoned
- Projects that can easily be modified according to the contingent state are more valuable than those that don’t provide such flexibility

Flexibility & Real Options

Decision Trees - Diagram of sequential decisions and possible outcomes.

- Decision trees help companies determine their options by showing the various choices and outcomes.
- The option to avoid a loss or produce extra profit has value.
- The ability to create an option thus has value that can be bought or sold.

Decision Trees



➔ Each square represents an action or decision by the company

➔ Each circle represents an outcome revealed by fate

Real Options

- **Real Options** – Rights to invest, modify, or dispose of a capital investment project

1. **Option to expand**
2. **Option to abandon**
3. **Timing option** (invest now or invest latter)
4. **Flexible production facilities**

   (dual-fired boilers)