Chapter 10
Project Analysis

Financial Management (MGCM10018)

Preview

- Chapters 8 and 9 develop a framework for project analysis.
- Project evaluation should never be a mechanical exercise.
  - Where financial managers take a set of cash-flows forecasts and crank out a NPV.
- This chapter analyzes the robustness of a project's value by asking some "What-If" questions.

Outline

- How Firms Organize the Investment Process
- Some "What-If" Questions
- Break-Even Analysis
- Real Options and the Value of Flexibility

How Firms Organize the Investment Process (10.1)

- We learned how to evaluate a proposed investment.
  - But potential projects and accurate cash-flow forecasts don't fall from sky.
  - Promising investment opportunities have to be identified.
  - Systems that facilitate effective communication across parts of organization are needed.

How Firms Organize the Investment Process (continued)

- For most firms, investments are evaluated in two separate stages.
  - Stage 1: Capital Budget
  - Stage 2: Project Authorizations

Capital Budget

- Once a year, the head office generally asks each of its divisions and plants to provide a list of investments that they like to make.
- These are gathered together into a proposed capital budget.
  - A list of planned investment projects.
- The budget is then reviewed and pruned by senior management and staff specializing in planning and financial analysis.

Capital Budget (continued)

- Investment proposals can bubble up from the bottom of the organization.
  - They are also likely to come from higher up.
- Senior management's concern is to see that capital budget matches the firm's strategic plans.
- Thus, the firm's capital investment choices should reflect both bottom-up and top-down process.
  - Plant and division managers see the trees and strategic planners see the forest.

Project Authorizations

- Before a project is exercised, we will need to draw up a detailed proposal setting out particulars of the project, engineering analyses, cash-flow forecasts, and present value calculations.
- Type of information:
  - Outlays required by law or company policy
  - Maintenance or cost reduction
  - Capacity expansion in existing business
  - Investment for new products

Problems and Some Solutions

- Capital budgeting is a cooperative effort, and it brings some challenges.
  - Ensuring that forecasts are consistent
  - Eliminating conflicts of interest
  - Reducing forecast bias
  - Proper selection criteria (NPV and others)

Ensuring Forecasts are Consistent

- Inconsistent assumptions often creep into investment proposals.
  - Economic perspectives may be formed differently across units.
  - Forecasts of sales might be estimated differently by marketing and production divisions.
- Many firms begin the capital budgeting process by establishing forecasts of economic indicators, such as inflation and the growth in national income.

Eliminating Conflicts of Interest

- When interests of managers conflict with those of stockholders, poor managements occur.
  - For example, new plant managers prefer quick-payback projects even if NPV is sacrificed.
- This is important for the boards (or key decision makers) of firms to look out such conflicts.
- Does a firm often demand quick results?
  - This may be due to the firm's culture or its leaders' characteristics.

Reducing Forecast Bias

- Someone who is keen to get a project proposal accepted is also likely to look on the bright side when forecasting cash flows.
  - This is called over-optimism.
  - Examples: most large public projects such as missile, dam, and highway cost much more than they are originally forecast.
- Note that capital investment decisions are effectively decentralized!

Proper Selection Criteria

- Senior managers are continuously bombarded with requests for funds for capital expenditures.
  - All the requests are supported with positive NPV.
- One can impose rigid expenditure limits on individual plants or divisions.
- One can use alternative selection criteria to evaluate the projects.
  - Sorting the wheat from the chaff! 去蕪存菁

What-If Testing (10.2)

- What-if questions ask what will happen to a project in various circumstances.
  - What will happen if the economy enters a recession?
  - What if a competitor enters the market?
  - What if costs turn out to be higher than anticipated?
- What-if analysis can help to identify the inputs that are most worth refining before we commit to a project.

What-If Testing (continued)

- Sensitivity Analysis - analysis of the effects on project profitability of changes in sales, costs, etc.
- Scenario Analysis – analysis given a particular combination of assumptions.
- Simulation Analysis - estimation of the probabilities of different possible outcomes.
- Break-Even Analysis - analysis of the level of sales at which the company breaks even.

Sensitivity Analysis

- Sensitivity analysis is to analyze the effects on project profitability of changes in sales, costs, etc.

- Why is sensitivity analysis useful?

Sensitivity Analysis - Example

Base Case: Expected cash flows from a new project (with 8% opportunity cost of capital; 40% average tax rate; variable costs are a constant 80% of sales; all numbers in $000s)

	Year 0	Years 1-12
Investment	-5,400	
Sales		16,000
Variable Costs		(12,800)
Fixed Costs		(2,000)
Depreciation		(450)
Pretax profit		750
Taxes		(300)
Profit after tax		450
Operating cash flow		900
Net Cash Flow	-5,400	900

NPV = $1,382.47

IRR = 12.7%

Payback Period = 6 years

Profitability Index = .256

Sensitivity Analysis - Example

Possible Range of Variables

	Range		
Variable	Pessimistic	Expected	Optimistic
Sales	14,000	16,000	18,000
Fixed Costs	2,500	2,000	1,500

Sensitivity Analysis: Changing Sales

(with 8% Opportunity Cost of Capital; 40% average tax rate; variable costs are a constant 80% of sales; all numbers in $000s)

Pessimistic Case—**Sales = $14,000**

Pessimistic Case	Year 0	Years 1-12
Investment	-5,400	
Sales		14,000
Variable Costs		(11,200)
Fixed Costs		(2,000)
Depreciation		(450)
Pretax profit		350
Taxes		(140)
Profit after tax		210
Operating cash flow		660
Net Cash Flow	-5,400	660

NPV = -$426

Optimistic Case—**Sales = $18,000**

Optimistic Case	Year 0	Years 1-12
Investment	-5,400	
Sales		18,000
Variable Costs		(14,400)
Fixed Costs		(2,000)
Depreciation		(450)
Pretax profit		1,150
Taxes		(460)
Profit after tax		690
Operating cash flow		1,140
Net Cash Flow	-5,400	1,140

NPV = $3,191

Sensitivity Analysis: Changing Fixed Costs

(with 8% Opportunity Cost of Capital; 40% average tax rate; variable costs are a constant 80% of sales; all numbers in $000s)

Pessimistic Case—**Fixed Costs = $2,500**

Pessimistic Case	Year 0	Years 1-12
Investment	-5,400	
Sales		16,000
Variable Costs		(12,800)
Fixed Costs		(2,500
Depreciation		(450)
Pretax profit		250
Taxes		(100)
Profit after tax		150
Operating cash flow		600
Net Cash Flow	-5,400	600

NPV = -$878

Optimistic Case—**Fixed Costs = $1,500**

Optimistic Case	Year 0	Years 1-12
Investment	-5,400	
Sales		16,000
Variable Costs		(12,800)
Fixed Costs		(1,500)
Depreciation		(450)
Pretax profit		1,250
Taxes		(500)
Profit after tax		750
Operating cash flow		1,200
Net Cash Flow	-5,400	1,200

NPV = $3,643

Sensitivity Analysis (continued)

- Sensitivity analysis expresses cash flows in terms of unknown variables and then calculates the consequences of misestimating those variables.
  - It forces managers to look at particular variables.
  - One drawback is that how can the managers consistently define optimistic or pessimistic?
  - Another problem is that underlying variables are likely to be interrelated.

Scenario Analysis

- Scenario analysis allows managers to look at different but consistent combinations of variables.
  - It provides possible outcomes of a project with a particular combination of assumptions.
  - Forecasters often prefer to give an estimate of revenues or costs under a particular scenario rather than to give some absolute optimistic or pessimistic value.

Scenario Analysis: Introducing Competition

Assume that it will take two years for competition to enter the market. At this time, sales drop 10% and variable costs increase to 82% (increased labor demand). What happens to NPV under this scenario?

Base Case – No Competition

	Year 0	Years 1-12
Investment	-5,400	
Sales		16,000
Variable Costs		(12,800)
Fixed Costs		(2,000)
Depreciation		(450)
Pretax profit		750
Taxes		(300)
Profit after tax		450
Operating cash flow		900
Net Cash Flow	-5,400	900

NPV = $1,382

Scenario – With Competition

	Year 0	Years 1-2	Years 3-12
Investment	-5,400		
Sales		16,000	14,400
Variable Costs		(12,800)	(11,800)
Fixed Costs		(2,000)	(2,000)
Depreciation		(450)	(450)
Pretax profit		750	142
Taxes		(300)	(57)
Profit after tax		450	85
Operating cash flow		900	535
Net Cash Flow	-5,400	900	535

NPV = -$717

Scenario Analysis (continued)

- In banking industry, such scenario analysis can be applied as stress test.
- One can impose a set of extreme risky scenarios and see if a particular bank or its branch can survive.
- There are quite a few software have been developed for such use.
  - Example: RiskMetrics Group (originally) from JP Morgan

Simulation Analysis

- Simulation analysis is an extension of scenario analysis.
  - Instead of specifying a relatively small number of scenarios, a computer generates several hundred or thousand possible combinations of variables.
  - They are based on variables' probability distributions.
  - Project NPV and other outcomes of interest can be calculated for each combination of variables.

Break-Even Analysis (10.3)

- Break-even analysis is analysis of the level of sales at which the project breaks even.
  - Managers are asking how far off the estimates could be before the project begins to lose money.
  - Most often, the break-even condition is defined in terms of accounting profits.
  - More properly, it should be defined in terms of net present value.

Break-Even Analysis – Example

(with 8% Opportunity Cost of Capital; 40% average tax rate; variable costs are a constant 80% of sales; all numbers in $000s)

$x =$ Number of Units Sold

	Year 0	Years 1-12
Investment	$5,400	
Sales		$45 \times X$
Var. Cost		$(36 \times X)$
Fixed Costs		$(2,000)$
Depreciation		(450)
Pretax Profit		$9 \times X - 2,450$
Taxes (40%)		$3.6 \times X - 980$
Net Profit		$5.4 \times X - 1,470$
Net Cash Flow	-5,400	$5.4 \times X - 1,020$

- Determine the number of units that must be sold in order to break even, on an NPV basis.
- Suppose each unit has a price point of $45,000
- All other variables are at their base case levels

Break-Even Point: Accounting

Break-Even Point (Accounting) - The break-even point is the number of units sold where net profits = $0.

$$0 = 5.4 \times X - 1,470$$

$$X = \frac{1,470}{5.4} = 273 \text{ Units}$$

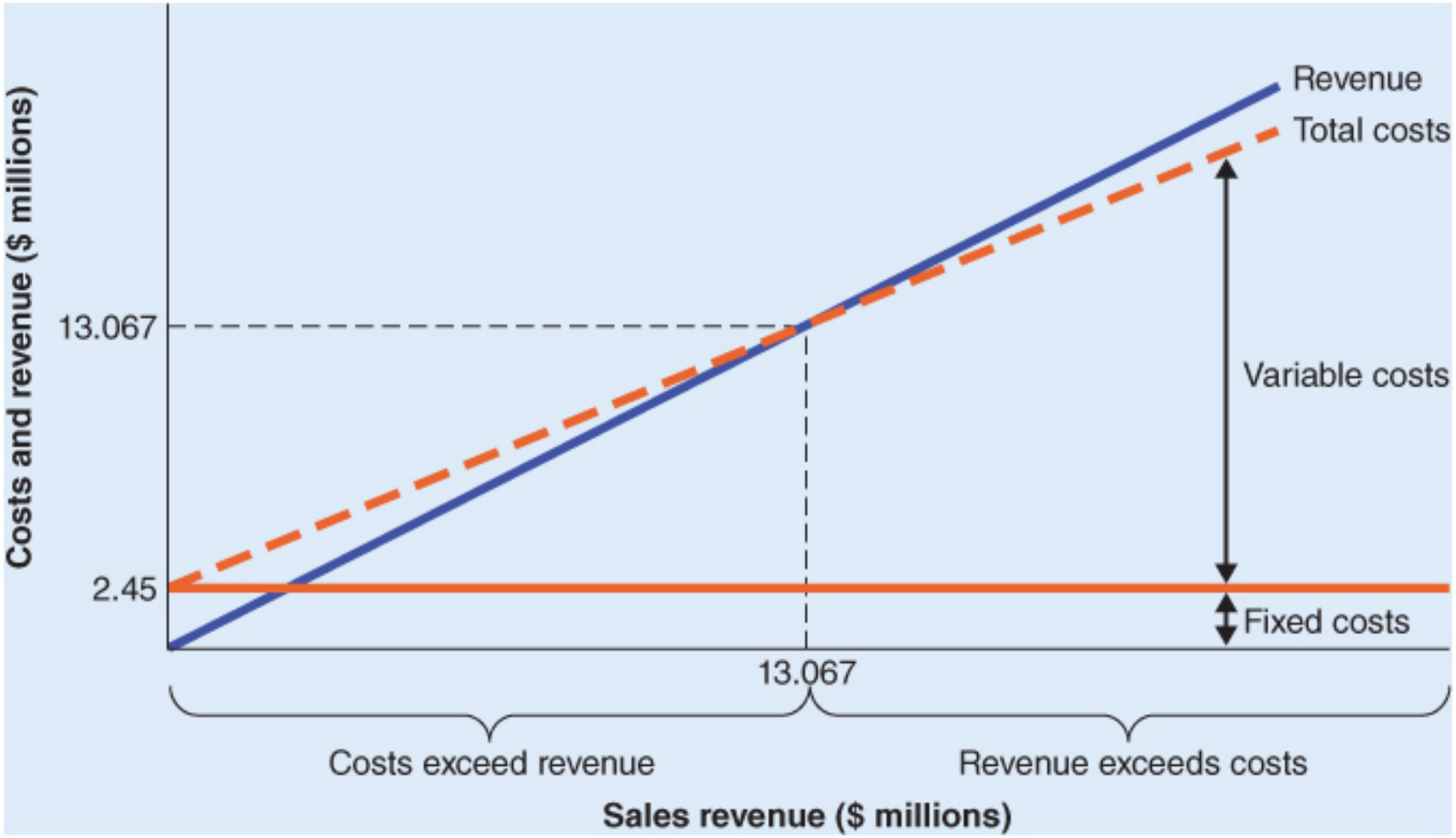
Note: Accounting Break-Even can be expressed in terms of revenue:

$$\text{Break-Even level of revenues} = \frac{\text{fixed costs + depreciation}}{\text{additional profit from each additional dollar of sales}}$$

What does the accounting break-even point not account for?

1. Depreciation is a non-cash item

Figure 10.1 - Accounting break-even analysis



Break-Even Point: Finance

NPV Break-Even Point (Finance):

How can we find the present value of future cash flows? As long as cash flows are equal each year, we can use the Annuity Factor.

Step 1: PV (Cash Flows) = Annuity Factor × Yearly Cash Flows

$$\text{where Annuity Factor} = \frac{1\text{-}(1+r)^{-t}}{r}$$

$$\text{Example: PV(Cash Flows)} = \frac{1-(1+.08)^{-12}}{.08} \times [5.4 \times X - 1,020]$$

Break-Even Analysis

Recall: the break-even point is the number of units sold where NPV = $0.

Step 2: PV (Cash Flows) = Initial Investment

Example-- $$\frac{1-(1+.08)^{-12}}{.08}\times[5.4\times X-1,020]=5,400$$

$$X=322 \text{ units}$$

Operating Leverage

- A project's break-even point depends on both its fixed costs and the profit on each extra sale.
  - Managers often face a trade-off between these variables.
  - Operating leverage shows the degree to which costs are fixed.
    - High operating leverage magnifies the effect on profits of a fluctuation in sales.

Operating Leverage (continued)

- We can measure a business's operating leverage by asking how much profits change for each 1% change in sales.
  - This is defined as the degree of operating leverage (DOL).

$$DOL = \frac{\text{percent change in profits (pre-tax)}}{\text{percent change in sales}}$$

$$= 1 + \frac{\text{fixed costs}}{\text{profits}}$$

Degree of Operating Leverage: Example

Base Case	Year 0	Years 1-12
Investment	-5,400	
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Fixed Costs		(2,000)
Depreciation		(450)
Pretax profit		750
Taxes		(300)
Profit after tax		450
Operating cash flow		900
Net Cash Flow	-5,400	900

Optimisic Sales	Year 0	Years 1-12
Investment	-5,400	
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Variable Costs		(14,400)
Fixed Costs		(2,000)
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Net Cash Flow	-5,400	1,140

$$\%\ \text{Change in Profits} = \frac{\text{New} - \text{Old}}{\text{Old}} = \frac{1{,}150 - 750}{750} = .5333$$

$$\%\ \text{Change in Sales} = \frac{18{,}000 - 16{,}000}{16{,}000} = .1250$$

$$\text{DOL} = \frac{\%\ \text{Change in Profits}}{\%\ \text{Change in Sales}} = \frac{.5333}{.1250} = 4.27$$

Estimated DOL for large U.S. companies by industry

High-Leverage Industries		Low-Leverage Industries	
	DOL		DOL
Steel	2.20	Electric utilities	.56
Railroad	1.99	Food	.79
Auto	1.57	Clothing	.88

Real Options (10.4)

- Most tools for project analysis ignore opportunities in modifying projects.
  - Projects that can easily be modified are more valuable than those don't have such flexibility.
  - More uncertain the outlook, more valuable this flexibility becomes.
- Real options are options to invest in, modify, or dispose of a capital investment project.

Real Options (continued)

- Four types of real options:
  - Option to expand
  - Option to abandon
  - Timing option
  - Flexible production facilities

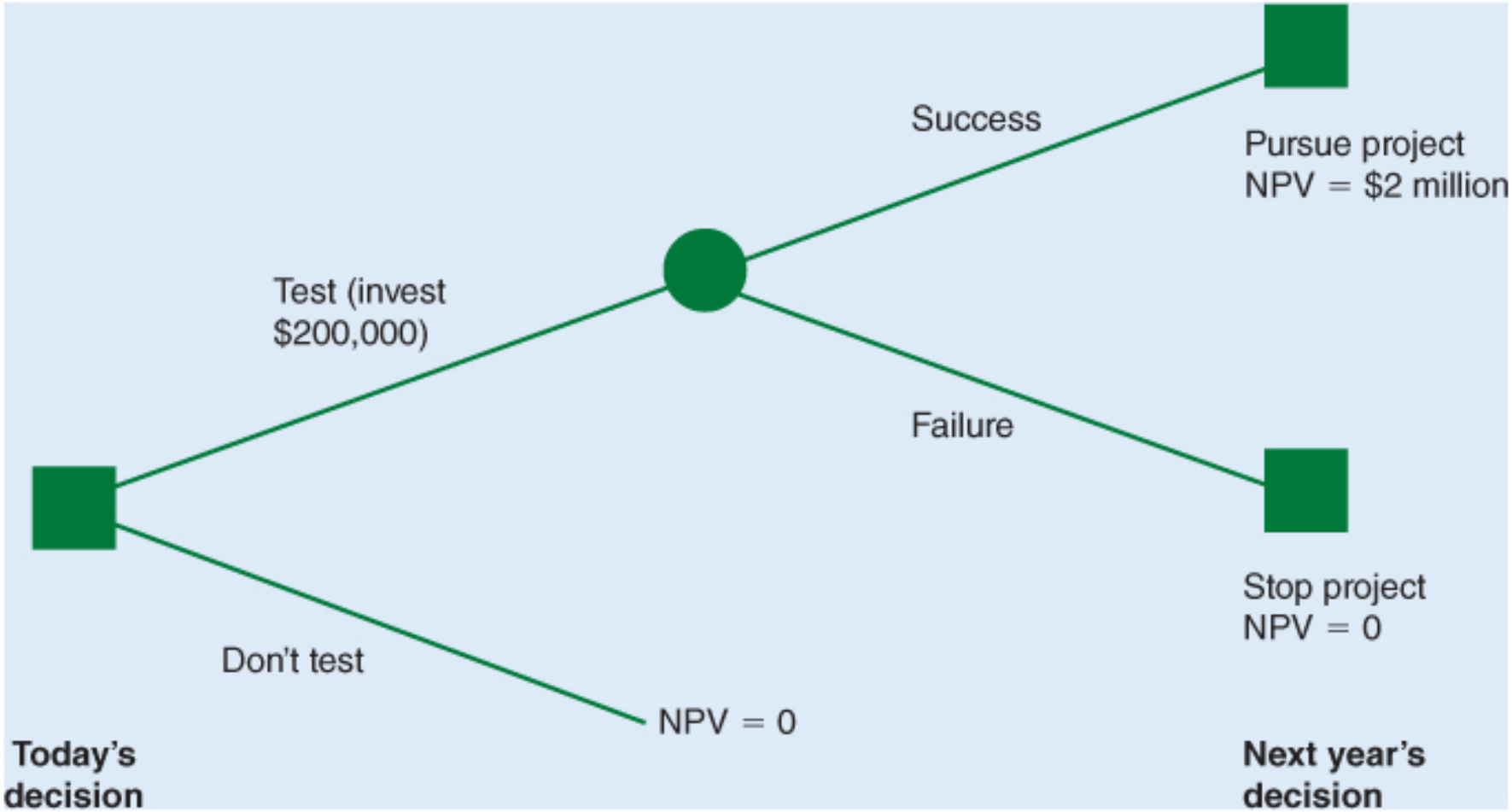
Option to Expand

- Scientists at MacCaugh have developed a diet whiskey, and the firm is ready to go ahead with pilot production and test-marketing.
  - The pilot program will take a year with cost of $200,000.
  - There is a 50-50 chance the pilot program works.
  - If so, a $2 million plant will generate annual cash flow in perpetuity of $480,000 after tax.
  - Given 12% cost of capital, NPV = -$2 million + $480,000/0.12 = $2 million.

Option to Expand (continued)

- Decision Trees are diagram of sequential decisions and possible outcomes.
  - Decision trees help companies determine their options by showing various choices and outcomes.
  - The option to avoid a loss or produce extra profit has value.
  - The ability to create an option has value that can be bought or sold.

Decision Trees: Example



Option to Abandon

- The decision to terminate a project is usually taken by management.
  - Once the project is no longer profitable, the company will cut its losses and abandon it.
  - Tangible assets are easier to sell than intangible ones.
  - Some assets may have negative abandonment value.
    - For example, it is costly to decommission nuclear power plants.

The Timing Option

- A certain project can be a big winner or big loser.
- The project has positive NPV today, but it is not a "now or never" project.
  - We then have choices to go with it now or later.
  - For example, we are considering development of a new oil field.
    - The timing of such project highly depends on the price of crude oil, which are very volatile.

Flexible Production Facilities

- Many manufacturing operations have built-in flexibility to vary their output mix as demand changes.
  - For example, fashion changes have made the pattern of demand in the knitwear industry difficult to predict.
  - Thus, firms have increasingly invested in computer-controlled knitting machines, which provide an option to vary the product mix.