

Key Concepts and Skills

- Understand forecasting risk and sources of value
- Understand and be able to conduct scenario and sensitivity analysis
- Understand the various forms of break-even analysis
- Understand operating leverage
- Understand capital rationing and its effects

Chapter Outline

- Evaluating NPV Estimates
- Scenario and Other What-If Analyses
- Break-Even Analysis
- Operating Cash Flow, Sales Volume, and Break-Even
- Operating Leverage
- Capital Rationing

Evaluating NPV Estimates

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- NPV estimates are just that – estimates
 - A positive NPV is a good start – now we need to take a closer look
 - Forecasting risk: how sensitive is our NPV to changes in the cash flow estimates; the more sensitive, the greater the forecasting risk
 - Sources of value: why does this project create value?

Scenario Analysis

- What happens to the NPV under different cash flow scenarios?
- At the very least, look at:
 - Best case: high revenues, low costs
 - Worst case: low revenues, high costs
 - Measure of the range of possible outcomes
- Best case and worst case are not necessarily probable, but they can still be possible

New Project Example

- Consider the project discussed in the text
- The initial cost is \$200,000, and the project has a 5-year life. There is no salvage. Depreciation is straight-line, the required return is 12%, and the tax rate is 34%.
- The base case NPV is 15,566



Summary of Scenario Analysis



Scenario	Net Income	Cash Flow	NPV	IRR
Base case	19,800	59,800	15,566	15.1%
Worst Case	-15,510	24,490	-111,719	-14.4%
Best Case	59,730	99,730	159,504	40.9%

Sensitivity Analysis

- In sensitivity analysis, only one variable is changed while the rest are held constant.
- This is a subset of scenario analysis where we are looking at the effect of specific variables on NPV
- The greater the volatility in NPV in relation to a specific variable, the larger the forecasting risk associated with that variable, and the more attention we want to pay to its estimation



Summary of Sensitivity Analysis by Changing Unit Sales

	Unit Sales	Cash Flow	NPV	IRR
Base case	6,000	59,800	15,566	15.1%
Worst case	5,500	53,200	-8,226	10.3%
Best case	6,500	66,400	39,357	19.7%

Simulation Analysis

- Simulation is really just an expanded sensitivity and scenario analysis
- Monte Carlo simulation can estimate thousands of possible outcomes based on conditional probability distributions and constraints for each of the variables
- The output is a probability distribution for NPV with an estimate of the probability of obtaining a positive net present value
- The simulation only works as well as the information that is entered, and very bad decisions can be made if care is not taken to analyze the interaction between variables

Making a Decision

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- Beware “Paralysis of Analysis”
 - At some point you have to make a decision
 - If the majority of your scenarios have positive NPVs, then you can feel reasonably comfortable about accepting the project
 - If you have a crucial variable that leads to a negative NPV with a small change in the estimates, then you may want to forego the project

Break-Even Analysis

- Common tool for analyzing the relationship between sales volume and profitability
- There are three common break-even measures
 - Accounting break-even: sales volume at which $NI = 0$
 - Cash break-even: sales volume at which $OCF = 0$
 - Financial break-even: sales volume at which $NPV = 0$

Example: Costs

- There are two types of costs that are important in breakeven analysis: variable and fixed
 - Total variable costs = quantity * cost per unit
 - Fixed costs are constant, regardless of output, over some time period
 - Total costs = fixed + variable = $FC + Qv$
- Example:
 - Your firm pays \$3,000 per month in fixed costs and \$15 per unit to produce the product.
 - What is your total cost if you produce 1,000 units?
 - What if you produce 5,000 units?

Average vs. Marginal Cost

- Average Cost
 - $TC / \text{number of units}$
 - Will decrease as number of units increases
- Marginal Cost
 - The cost to produce one more unit
 - Same as variable cost per unit
- Example: What is the average cost and marginal cost under each situation in the previous example
 - Produce 1,000 units: Average cost = $(\$3,000 + \$15 \times 1,000) / 1,000 = 18,000 / 1000 = \18
 - Produce 5,000 units: Average cost = $(\$3,000 + \$15 \times 5,000) / 5,000 = 78,000 / 5000 = \15.60
 - Marginal cost = variable cost = \$15

Accounting Break-Even

Accounting breakeven is where profits = 0

$$\text{Total Revenue} - \text{Total Costs} = 0$$

$$\text{Total Revenue} - \text{Variable Cost} - \text{Fixed Cost} - \text{Dep} - \text{Tax} = 0$$

$$(QP - Qv - FC - D)(1 - T) = 0$$

$$Q(P - v) = FC + D$$

$$Q = (FC + D) / (P - v)$$

$$\text{accounting break - even quantity} = \frac{\text{Fixed Costs} + \text{Dep}}{\text{Price} - \text{Variable Costs}}$$

Using Accounting Break-Even

- Accounting break-even is often used as an early stage screening number
- If a project cannot break-even on an accounting basis, then it is not going to be a worthwhile project
- Accounting break-even gives managers an indication of how a project will impact accounting profit

Accounting Break-Even and Cash Flow

- We are more interested in cash flow than we are in accounting numbers
- As long as a firm has non-cash deductions, there will be a positive cash flow
- If a firm just breaks even on an accounting basis, cash flow = depreciation
- If a firm just breaks even on an accounting basis, NPV will generally be < 0

Example: Accounting Break-Even and Cash Flow

Consider the following project

- A new product requires an initial investment of \$5 million and will be depreciated to an expected salvage of zero over 5 years
- The price of the new product is expected to be \$25,000, and the variable cost per unit is \$15,000
- The fixed cost is \$1 million
- The tax rate is 20%
- What is the accounting break-even point each year?
 - $Q = (FC + D) / (P - v)$
 - Depreciation = $5,000,000 / 5 = 1,000,000$
 - $Q = (1,000,000 + 1,000,000) / (25,000 - 15,000) = 200$ units

Cash Break-Even

- Cash Break-even is where Operating Cash Flow (OCF) = 0
- OCF is defined as follows:

$$\begin{aligned} \text{OCF} &= (S - VC - FC - D) (1 - T) + D \\ &= (QP - Qv - FC - D)(1 - T) + D \end{aligned}$$

- Setting OCF to 0 gives us the equation for the cash break-even quantity:

$$\begin{aligned} (QP - Qv - FC - D)(1 - T) + D &= 0 \\ Q(P - v) (1 - T) - FC (1 - T) - D + DT + D &= 0 \\ Q(P - v) (1 - T) &= FC (1 - T) + DT = 0 \end{aligned}$$

$$\begin{aligned} \text{cash break-even quantity} &= \frac{\text{Fixed Costs } (1 - T) - \text{Dep } (T)}{(\text{Price} - \text{Variable Costs}) (1 - T)} \\ &= \frac{FC (1 - T) - DT}{(P - v) (1 - T)} \end{aligned}$$

Example: Cash Break-Even

Consider the following project

- A new product requires an initial investment of \$5 million and will be depreciated to an expected salvage of zero over 5 years
- The price of the new product is expected to be \$25,000, and the variable cost per unit is \$15,000
- The fixed cost is \$1 million
- The tax rate is 20%.
- What is the cash break-even quantity each year?
 - $Q = [FC (1-T) + DT] / [(P - v) (1-T)]$
 - $Q = [1m(0.8) + 1m(0.2)] / (25,000 - 15,000)(0.8) = 125 \text{ units}$

Three Types of Break-Even Analysis

- Accounting Break-even
 - Where $NI = 0$
 - $Q = (FC + D) / (P - v)$
- Cash Break-even
 - Where $OCF = 0$
 - $Q = [FC (1 - T) + DT] / [(P - v) (1 - T)]$
 - $Q = FC / (P - v)$ (ignoring taxes)
- Financial Break-even or Present Value Break-even
 - Where $NPV = 0$
- Cash BE < Accounting BE < Financial BE

Financial or PV Break-Even

- Financial Break-even is where Operating Cash Flow (OCF) = Equivalent Annual Cost (EAC)

- OCF is defined as follows:

$$\begin{aligned} \text{OCF} &= (S - VC - FC - D) (1 - T) + D \\ &= (QP - Qv - FC - D)(1 - T) + D \end{aligned}$$

- Setting OCF to EAC gives us the equation for the financial break-even quantity:

$$(QP - Qv - FC - D)(1 - T) + D = \text{EAC}$$

$$Q(P - v) (1 - T) - FC (1 - T) + D T = \text{EAC}$$

$$Q(P - v) (1 - T) = \text{EAC} + FC (1 - T) - D T$$

$$\text{Financial Break - even quantity} = \frac{\text{EAC} + FC(1 - T) - \text{Dep}(T)}{(P - v)(1 - T)}$$

Example: Financial or PV Break-Even

Consider the following project

- A new product requires an initial investment of \$5 million and will be depreciated to an expected salvage of zero over 5 years
- The price of the new product is expected to be \$25,000, and the variable cost per unit is \$15,000
- The fixed cost is \$1 million
- The tax rate is 20%.
- What is the financial break-even quantity each year?

Assume a required return of 18%, EAC for a \$5m investment over 5 years at 18% = \$1,598,889.21

$$\begin{aligned} -Q &= [(EAC + FC(1-T) - DT) / [(P - v)(1-T)] \\ &= (1,598,889.21 + 1m(0.8) - 1m(0.2) / [(25,000 - 15,000)(0.8)] \\ &= 275 \text{ units} \end{aligned}$$

The question now becomes: Can we sell at least 275 units per year?

Operating Leverage

- Operating leverage is the relationship between sales and operating cash flow
- Degree of operating leverage measures this relationship
 - The higher the DOL, the greater the variability in operating cash flow
 - The higher the fixed costs, the higher the DOL
 - DOL depends on the sales level you are starting from

$$\text{DOL} = 1 + \frac{\text{FC}(1 - T) - \text{DT}}{\text{OCF}}$$

Ignoring taxes, this becomes

$$\text{DOL} = 1 + \frac{\text{FC}}{\text{OCF}}$$

Example: DOL

- Consider the previous example
- Suppose sales are 300 units
 - This meets all three break-even measures
 - What is the DOL at this sales level?
 - $OCF = (S - VC - FC - D)(1 - T) + D$
 $= [Q(P - v) - FC](1 - T) + DT$
 - $OCF = [300(25,000 - 15,000) - 1m](0.8) + 1m(0.2)$
 $= 1,800,000$
 - $DOL = 1 + [FC(1 - T) - DT] / OCF$
 $DOL = 1 + [1m(0.8) - 1m(0.2)] / 1,800,000 = 1.3333$
- What will happen to OCF if unit sales increases by 20%?
 - Percentage change in OCF = DOL * Percentage change in Q
 - Percentage change in OCF = $1.3333(.2) = .2667$ or 26.67%
 - OCF would increase to $1,800,000(1.2667) = 2,280,000$

Capital Rationing

- Capital rationing occurs when a firm or division has limited resources
 - Soft rationing – the limited resources are temporary, often self-imposed
 - Hard rationing – capital will never be available for this project
- The profitability index is a useful tool when a manager is faced with soft rationing

Quick Quiz

- What is sensitivity analysis, scenario analysis and simulation?
- Why are these analyses important, and how should they be used?
- What are the three types of break-even analysis, and how should each be used?
- What is the degree of operating leverage?
- What is the difference between hard rationing and soft rationing?

Ethics Issues

- Is it ethical for a medical patient to pay for a portion of R&D costs (since experimental procedures are not covered by insurance) prior to the introduction of the final product? Is it proper for physicians to recommend this procedure when they have a vested interest in its usage?

Comprehensive Problem

- A project requires an initial investment of \$1,000,000 and is depreciated straight-line to zero salvage over its 10-year life. The project produces items that sell for \$1,000 each, with variable costs of \$700 per unit. Fixed costs are \$350,000 per year.
- What is the accounting break-even quantity?
- What is the operating cash flow at accounting break-even?
- What is the DOL at the accounting break-even?



End of Chapter