



## Finance for Cultural Organisations

### Lecture 9. Capital Budgeting: Project Analysis and Evaluation



# Lecture 9. Capital Budgeting: Project Analysis & Evaluation

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- Understand forecasting risk and sources of value
  - Understand and be able to do scenario and sensitivity analysis
  - Understand the various forms of break-even analysis
  - Understand operating leverage
  - Understand capital rationing
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- Reading
  - RWJ Ch11, HBP Ch7.

# Chapter Outline

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- 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

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- 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

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- 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 15,567



# Summary of Scenario Analysis

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Scenario	Net Income	Cash Flow	NPV	IRR
Base case	19,800	59,800	15,567	15.1%
Worst Case	-15,510	24,490	-111,719	-14.4%
Best Case	59,730	99,730	159,504	40.9%

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# Sensitivity Analysis

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- What happens to NPV when we vary one variable at a time
- 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 for New Project

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Scenario	Unit Sales	Cash Flow	NPV	IRR
Base case	6000	59,800	15,567	15.1%
Worst case	5500	53,200	-8,226	10.3%
Best case	6500	66,400	39,357	19.7%

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# Simulation Analysis

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- 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

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- 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 net income = 0
  - Cash break-even – sales volume at which operating cash flow = 0
  - Financial break-even – sales volume at which net present value = 0

# Example: Costs

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- 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 =  $FC + vQ$
- Example:
  - Your firm pays \$3000 per month in fixed costs. You also pay \$15 per unit to produce your product.
    - What is your total cost if you produce 1000 units?
    - What if you produce 5000 units?



# Average vs. Marginal Cost

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- Average Cost
  - $TC / \# \text{ of units}$
  - Will decrease as  $\#$  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 1000 units: Average =  $18,000 / 1000 = \$18$
  - Produce 5000 units: Average =  $78,000 / 5000 = \$15.60$



# Accounting Break-Even

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- The quantity that leads to a zero net income
- $NI = (\text{Sales} - VC - FC - D)(1 - T) = 0$
- $QP - vQ - FC - D = 0$
- $Q(P - v) = FC + D$
- $Q = (FC + D) / (P - v)$



# Using Accounting Break-Even

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- 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

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- 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,  $NPV < 0$

# Example

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- 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
  - What is the accounting break-even point each year?
    - Depreciation =  $5,000,000 / 5 = 1,000,000$
    - $Q = (1,000,000 + 1,000,000) / (25,000 - 15,000) = 200$  units



# Sales Volume and Operating Cash Flow

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- What is the operating cash flow at the accounting break-even point (ignoring taxes)?
  - $OCF = (S - VC - FC - D) + D$
  - $OCF = (200 * 25,000 - 200 * 15,000 - 1,000,000 - 1,000,000) + 1,000,000 = 1,000,000$
- What is the cash break-even quantity?
  - $OCF = [(P-v)Q - FC - D] + D = (P-v)Q - FC$
  - $Q = (OCF + FC) / (P - v)$
  - $Q = (0 + 1,000,000) / (25,000 - 15,000) = 100 \text{ units}$

# Three Types of Break-Even Analysis

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- Accounting Break-even
  - Where  $NI = 0$
  - $Q = (FC + D)/(P - v)$
- Cash Break-even
  - Where  $OCF = 0$
  - $Q = (FC + OCF)/(P - v)$  (ignoring taxes)
- Financial Break-even
  - Where  $NPV = 0$
- Cash BE < Accounting BE < Financial BE



# Example: Break-Even Analysis

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- Consider the previous example
  - Assume a required return of 18%
  - Accounting break-even = 200
  - Cash break-even = 100
  - What is the financial break-even point?
    - Similar process to that of finding the bid price
    - What OCF (or payment) makes NPV = 0?
      - $N = 5$ ;  $PV = 5,000,000$ ;  $I/Y = 18$ ;  $CPT\ PMT = 1,598,889 = OCF$
    - $Q = (1,000,000 + 1,598,889) / (25,000 - 15,000) = 260$  units
- The question now becomes: Can we sell at least 260 units per year?



# Operating Leverage

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- 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
- $DOL = 1 + (FC / OCF)$



# Example: DOL

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- Consider the previous example
- Suppose sales are 300 units
  - This meets all three break-even measures
  - What is the DOL at this sales level?
  - $OCF = (25,000 - 15,000) * 300 - 1,000,000 = 2,000,000$
  - $DOL = 1 + 1,000,000 / 2,000,000 = 1.5$
- What will happen to OCF if unit sales increases by 20%?
  - Percentage change in OCF =  $DOL * \text{Percentage change in } Q$
  - Percentage change in OCF =  $1.5(.2) = .3$  or 30%
  - OCF would increase to  $2,000,000(1.3) = 2,600,000$

# Capital Rationing

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- 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

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- 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 and how should each be used?
- What is degree of operating leverage?
- What is the difference between hard rationing and soft rationing?



# Comprehensive Problem

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- 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, operating cash flow at accounting break-even, and DOL at that output level?