

Operations Research

Prepared by Dr. Mohamed Eassa

IT 262

Operations Research

Lecture 1



Introduction to Operations Research

Lecture 1

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Operations Research

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Reference Book

- **Operations Research: An Introduction, Hamdy A. Taha.**
10th edition.
- **Introduction to Operations Research, F. Hillier & G. Lieberman.**

Course Outlines



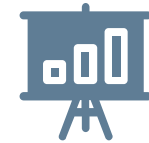
The nature of operations research



**Linear programming:
Formulations and
graphical solution**



**Algebraic solution: the
simplex methods and
dual-simplex method**



Sensitivity analysis



**Transportation
problems**



Assignment problems

Course Objectives

Knowing the emergence and nature of operations research.



Learn about systems analysis and how to formulate a problem mathematically.



Understand linear programming and related sensitivity analysis.



Understand and solve transportation problem and other topics related to the course

Chapter

01

Introduction to Operations Research





Chapter

01

Chapter Topics

- ❖ **The Management Science Approach to Problem Solving**
- ❖ **Model Building: Break-Even Analysis**
- ❖ **Management Science Modeling Techniques**

Definition of Operations Research



Operations research is a scientific method of providing executive departments with a quantitative basis for decisions regarding the operations under their control. (*Morse and Kimball*)

Definition of Operations Research

(Another Operation Research Definition)



Operations research is a logical and systematic approach to provide a rational basis for decision-making.

Management Science Approach



Management science uses a scientific approach to solving management problems.



It is used in a variety of organizations to solve many different types of problems.



It encompasses a logical mathematical approach to problem solving.

Management Science Approach

Six Steps involved in developing an Operational Research study

Step 1. Observe the problem environment:

- The activities that constitute this step are visits, conferences, observations, research and so on.
- With the help of such activities, the Operational Research scientist gets sufficient information and support to proceed and is better prepared to formulate the problem.

Management Science Approach

Step 2. Analyze and Define the problem:

- In this step not only, the problem is defined but also uses, objectives and limitations of the study are stressed in the light of the problem.
- The result of this step is a clear grasp of need for developing a solution and understanding its nature.

Management Science Approach

Step 3. Develop a Model:

- A model is a representation of some real or abstract situation.
- Operations research models are basically mathematical models representing systems. Processes or environment in the form of equations, relationships or formulae.
- The activities in this step include defining, inter-relationship, among variables,
- formulating equations, using known Operational research models.

Management Science Approach

Step 4. Select an Appropriate Data Input:

- No model will work appropriately if data input is not appropriate.
- Hence tapping the right kind of data is the vital step.
- Important activity in this step are analyzing internal – external data and facts.

Management Science Approach

Step 5. Provide a Solution and test reasonableness:

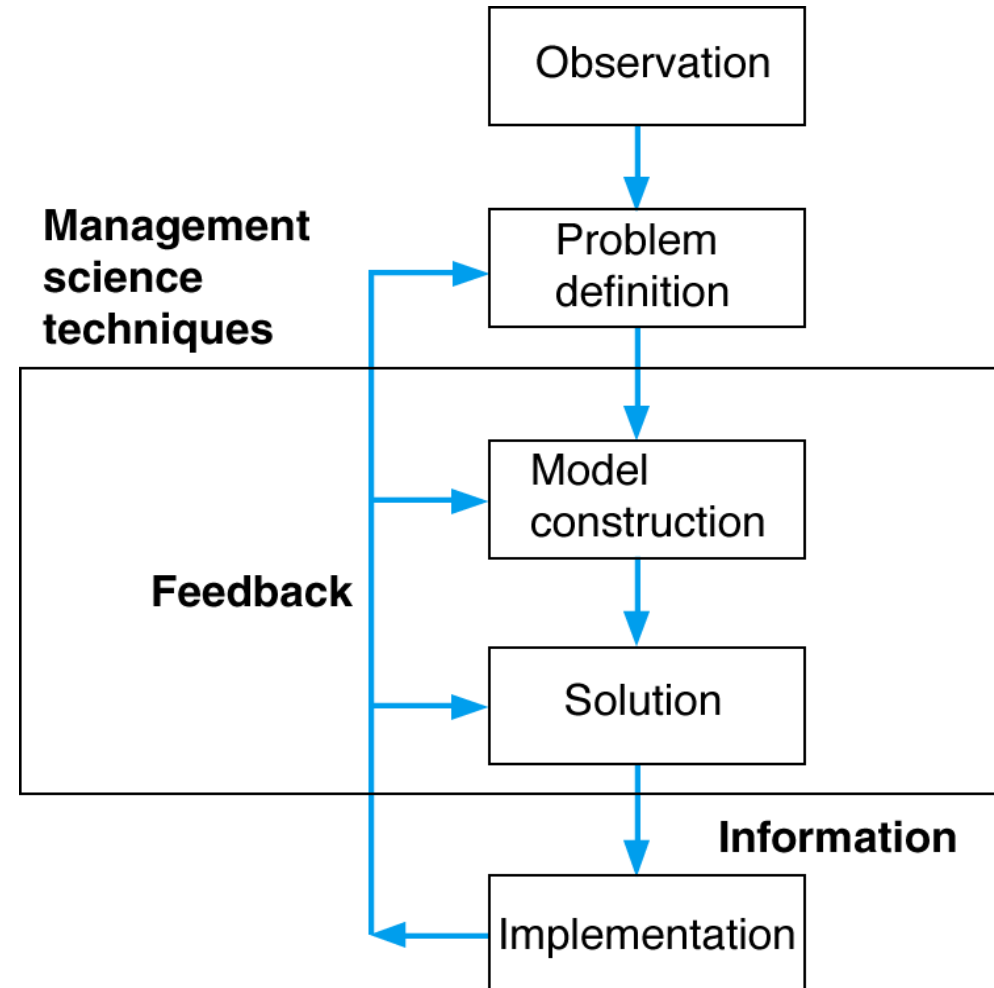
- This step involves getting a solution with the help of a model and data input.
- Such a solution is not implemented immediately.
- First it is tested, and limitations are found.
- If the solution is not reasonable or if the model is not behaving properly, updating and modifications of the model is considered.
- The end result of this step is a solution that is desirable and supports the current organizational objective.

Management Science Approach

Step 6. Implement the Solution:

- In operational research the decision making is scientific, and implementation of decision involves so many behavioral issues.
- Therefore, the implementation authority has to resolve the behavioral issues, sell the idea of use operational research not only to workers but also to superiors.

Management Science Approach



Steps in Management Science Approach

- **Observation** - Identification of a problem that exists in the system or organization.
- **Definition of the Problem** - problem must be clearly and consistently defined showing its boundaries and interaction with the objectives of the organization.
- **Model Construction** - Development of the functional mathematical relationships that describe the decision variables, objective function and constraints of the problem.
- **Model Solution** - Models solved using management science techniques.
- **Model Implementation** - Actual use of the model or its solution.

Limitations of Operational Research

Magnitude of Computation:

- Operations research tries to find out the optimal solution taking all the factors into account.
- In modern society, these factors are numerous and expressing them in quantity and establishing relationship among these, require huge calculations.

Limitations of Operational Research

Non- quantifiable Factors:

- Operations research provides solution only when all elements.
- related to a problem can be quantified.
- All relevant variables do not lend themselves to quantification.
- Factors which cannot be quantified, find no place in Operations research models.

Limitations of Operational Research

Distance between a manager and operations researcher:

- Operations researcher being a specialist's job requires a mathematician or a statistician who might not be aware of the business problem.
- Similarly, a manager fails to understand the complex working of operations research.
- Thus, there is a gap between the two.
- Management itself may offer a lot of resistance due to conventional thinking.

Limitations of Operational Research

Money and Time Cost:

- When the basic data is frequently changed, incorporating them into the operations research model is a costly affair.

Limitations of Operational Research

Implementation:

- Implementation of decision is a delicate task
- It must consider the complexities of human relations and behavior.
- Sometimes resistance is offered only due to psychological factors.

Problem Definition

Example of Model Construction (1 of 2)

Information and Data:

- ☐ Business firm makes and sells a steel product
- ☐ Product costs \$5 to produce
Product sells for \$20
- ☐ Product requires 4 pounds of steel to make
- ☐ Firm has 100 pounds of steel

Business Problem:

- Determine the number of units to produce to make the most profit given the limited amount of steel available.

Problem Definition

Example of Model Construction (2 of 2)

Variables: X = number of units (decision variable)

Z = total profit

Model: $Z = \$20X - \$5X$ (objective function)

$4X = 100$ lb of steel (resource constraint)

Parameters: \$20, \$5, 4 lbs, 100 lbs (known values)

Formal Specification of Model:

maximize $Z = \$20X - \$5X$

subject to $4X = 100$

Problem Definition

Example of Model Construction (2 of 2)

Formal Specification of Model:

subject to $4X = 100$

$$X = 25$$

number of units to produce is 25 Product

The total Profit $Z = \$20X - \$5X = \$15X = \375

Model Building

Break-Even Analysis

- Used to determine the number of units of a product to sell or produce (i.e. volume) that will equate total revenue with total cost.
- The volume at which total revenue equals total cost is called the break-even point.
- Profit at break-even point is zero.

Model Building

Break-Even Analysis

Model Components

- **Fixed Costs (c_f)** - costs that remain constant regardless of number of units produced.
- **Variable Cost (c_v)** - unit cost of product.
- **Total variable cost (vc_v)** - function of volume (v) and variable per- unit cost.
- **Total Cost (T_c)** - total fixed cost plus total variable cost.

$$T_c = c_f + vc_v$$

- **Profit (Z)** - difference between total revenue vp (p = price) and total cost.

$$Z = vp - T_c = vp - (c_f + vc_v)$$

$$Z = vp - c_f - vc_v$$

Model Building

Break-Even Analysis

Computing the Break-Even Point

The break-even point is that volume at which total revenue equals total cost and profit is zero:

$$Z = Vp - c_f - VC_v$$

$$0 = Vp - c_f - VC_v$$

$$Vp - VC_v = c_f$$

$$V(p - c_v) = c_f$$

$$V = c_f / (p - c_v)$$

Model Building

Break-Even Analysis

Computing the Break-Even Point

$$V = c_f / (p - c_v)$$

Example: Western Clothing Company

$$c_f = \$10000$$

$$c_v = \$8 \text{ per pair}$$

$$p = \$23 \text{ per pair}$$

$$V = c_f / (p - c_v) = 10000 / (23 - 8) = 666.7$$

$V = 666.7$ pairs, is the break-even point

Model Building Break-Even Analysis

Computing the Profit

$$Z = Vp - c_f - VC_v$$

Example: Western Clothing Company

$$c_f = \$10000$$

$$c_v = \$8 \text{ per pair}$$

$$p = \$23 \text{ per pair}$$

$$V = 400$$

$$Z = -4000 \text{ Profit}$$

Model Building Break-Even Analysis

Computing the Profit

$$Z = Vp - c_f - VC_v$$

Example: Western Clothing Company

$$c_f = \$10000$$

$$c_v = \$8 \text{ per pair}$$

$$p = \$23 \text{ per pair}$$

$$V = 1000$$

$$Z = 5000 \text{ Profit}$$

Model Building

Break-Even Analysis Graphical Solution

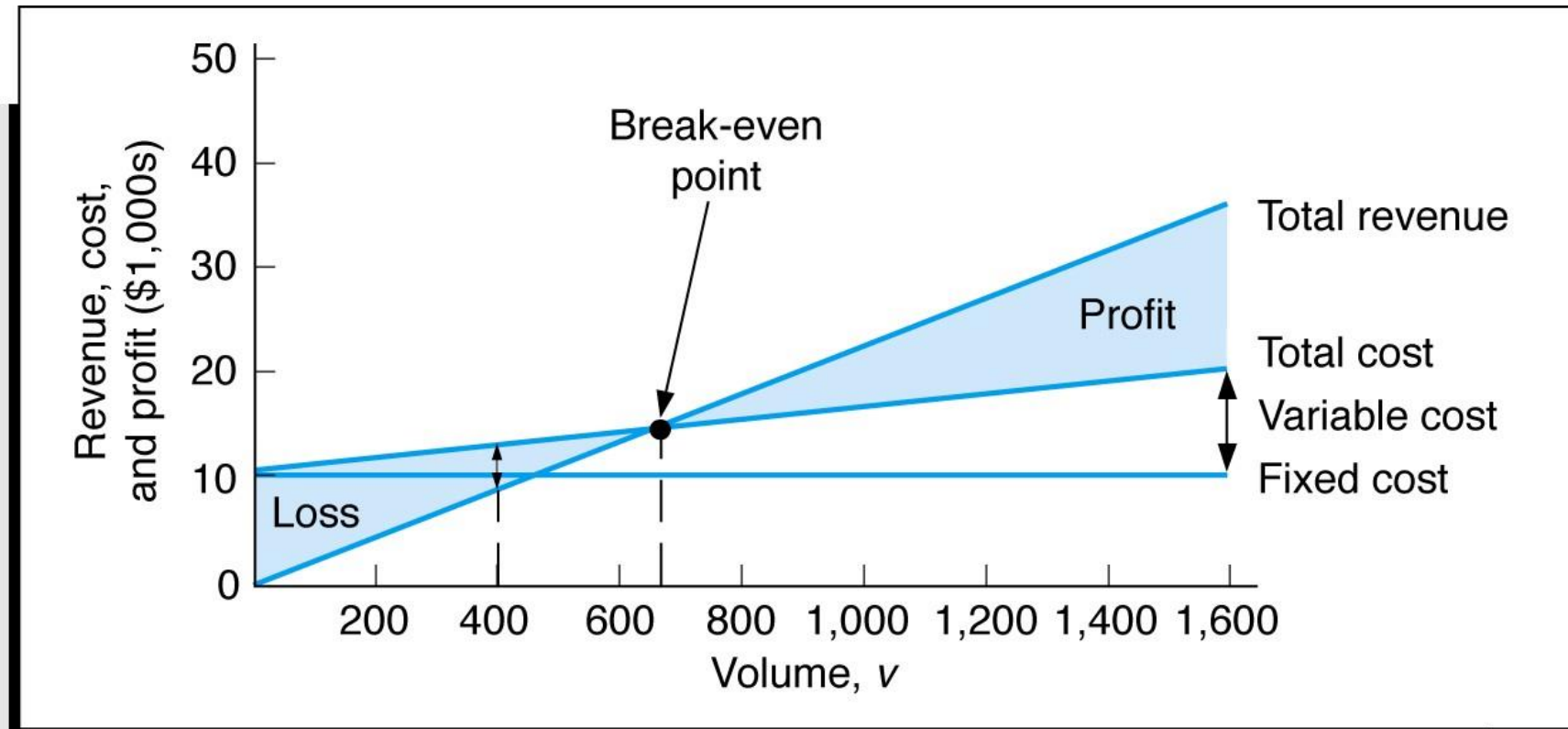


Figure : Break-Even Model

Model Building

Break-Even Analysis

Graphical Solution

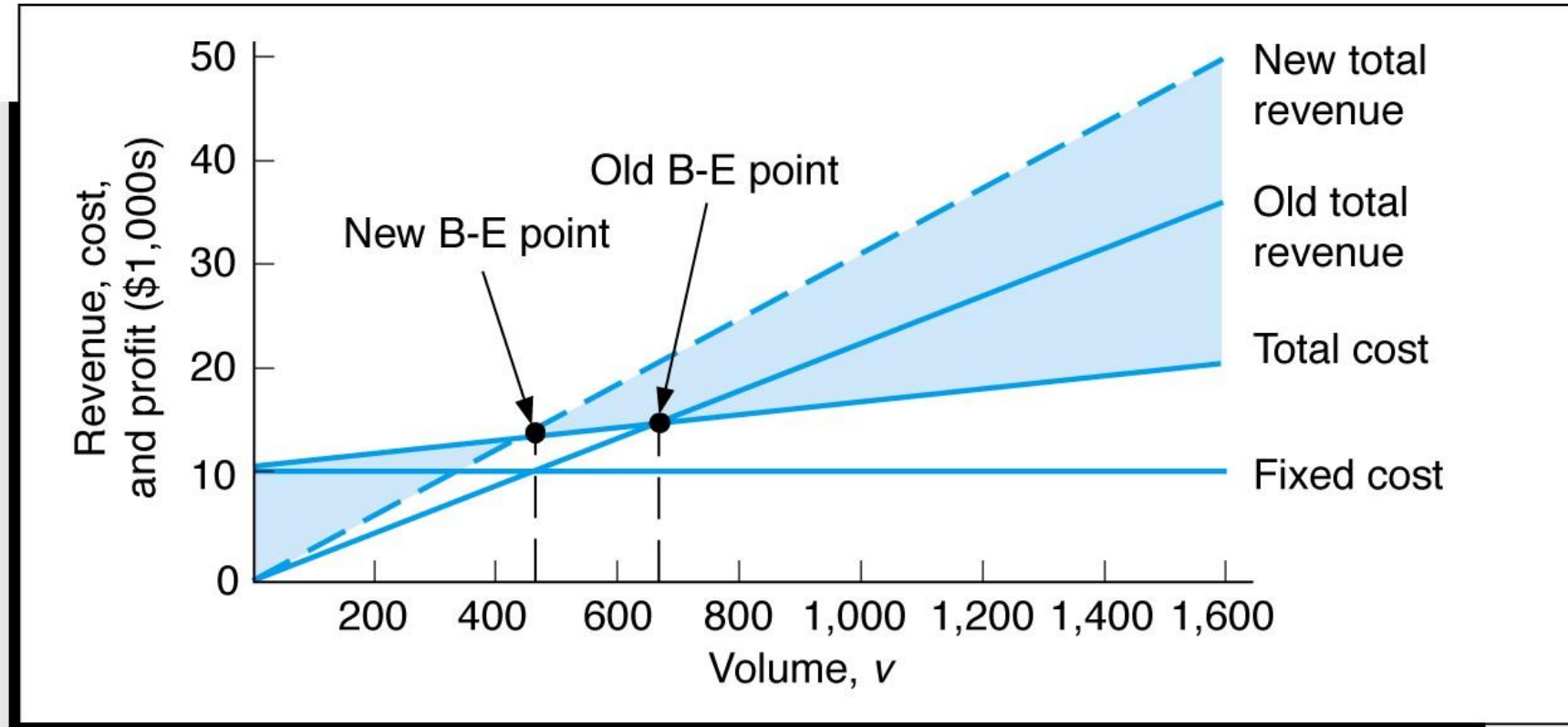


Figure : Sensitivity Analysis - Break-even Model with a Change in Price

Model Building

Break-Even Analysis Graphical Solution

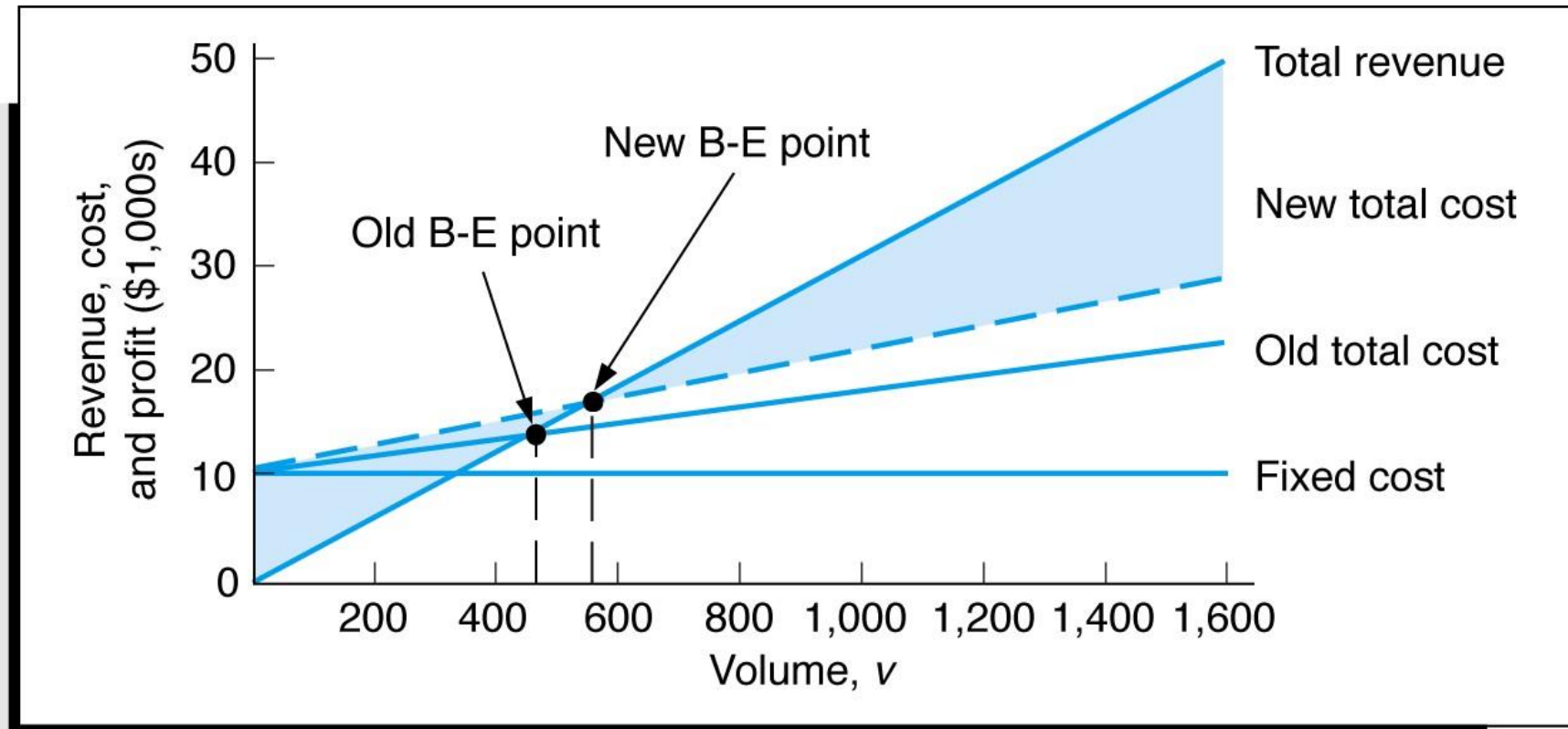


Figure : Sensitivity Analysis - Break-Even Model with a Change in Variable Cost

Model Building

Break-Even Analysis (7 of 7)

Graphical Solution

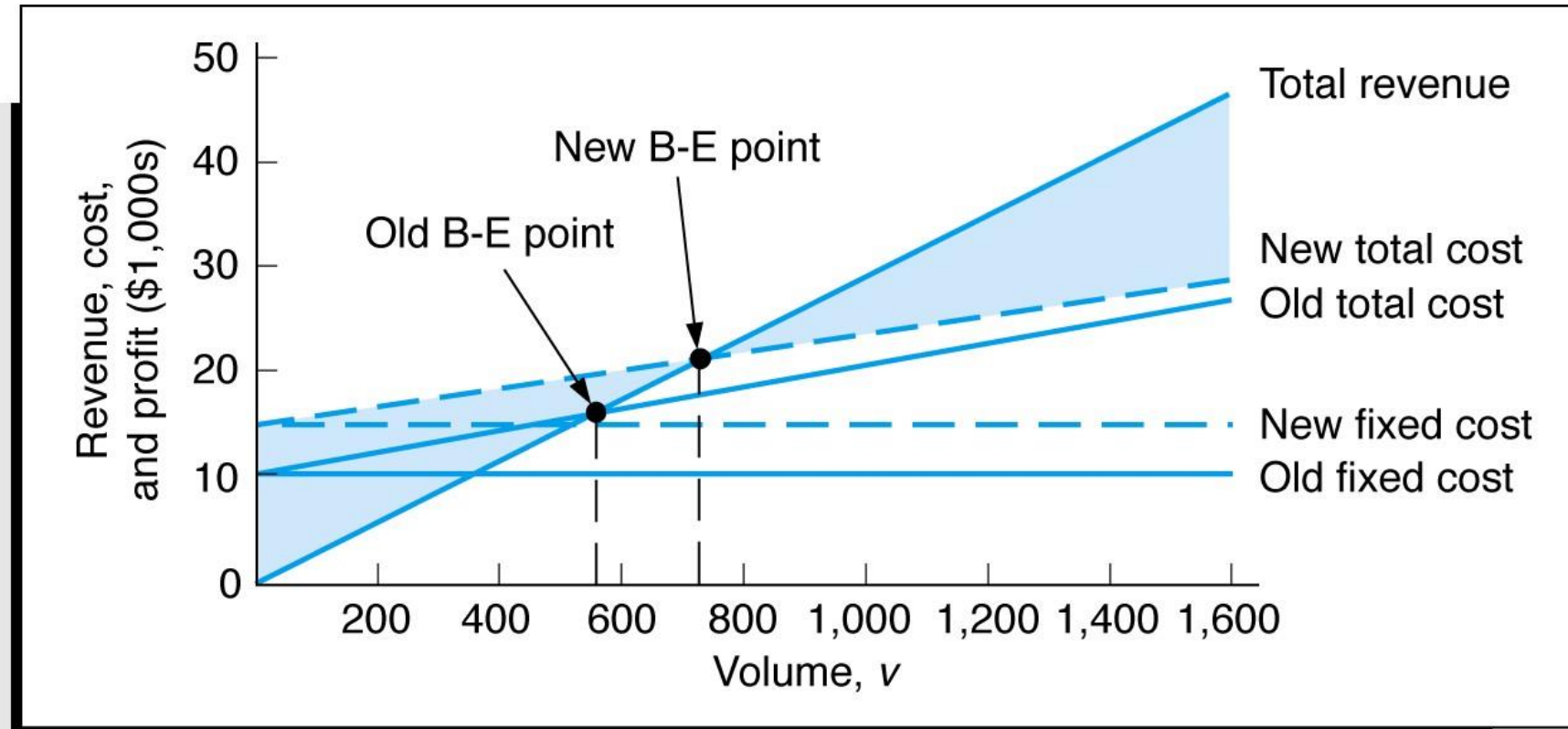


Figure : Sensitivity Analysis - Break-Even Model with a Change in Fixed Cost



Thank You