

BREAK-EVEN ANALYSIS

WHETHER OPERATING as nonprofit organizations or as investor-owned facilities, health care organizations must generate revenue to pay for the costs of providing services. Matching revenue generated to the costs of providing specific services is an important element of prudent financial management if the organization is to remain solvent.

Break-even analysis is a useful and frequently employed technique for determining the volume of service needed to ensure that revenue generated will exceed costs. This chapter describes this quantitative technique and its application to financial planning and management in health services organizations.

Introduction of Case Problem

Jefferson Community Health Plan is a nonprofit, full-service health maintenance organization operating in a tri-county region of a mid-western state. Jefferson is considering the development of a new satellite health center to serve a growing suburban area in its service region.

Consideration of the new facility has been stimulated by discussions between Jefferson and ARGO Industries. ARGO is a growing electronics company with a new plant in the suburban area where the health center would be located. ARGO Industries has proposed contracting with the Jefferson Community Health Plan to offer comprehensive health services for its employees on an annual capitated

payment basis. The capitated HMO plan would be offered as one of two health insurance options to ARGO's 2,500 employees.

Financial officers of Jefferson Community Health Plan have estimated the costs associated with the new health center as follows:

- | | |
|--|-------------|
| 1. Construction costs (to be amortized over ten years) | \$1,800,000 |
| 2. Capital equipment (to be amortized over ten years) | \$500,000 |
| 3. Fixed annual operating expenses (utilities, maintenance, central administration, security, etc.) | \$370,000 |
| 4. Variable annual operating costs per 100 enrollees in a capitated plan (based on financial data from other Jefferson units): | |
| a. Supplies and materials | \$15,000 |
| b. Clinical staff | \$76,000 |
| c. Support services | \$18,000 |
| d. Contract services (inpatient care) | \$48,000 |

In preliminary negotiations, ARGO has proposed contracting with Jefferson at an annual capitated payment of \$1,800 per enrollee in the HMO. ARGO's vice president for human resources has conducted an employee survey, and she estimates that initial annual enrollment would be 1,500 (employees and dependents).

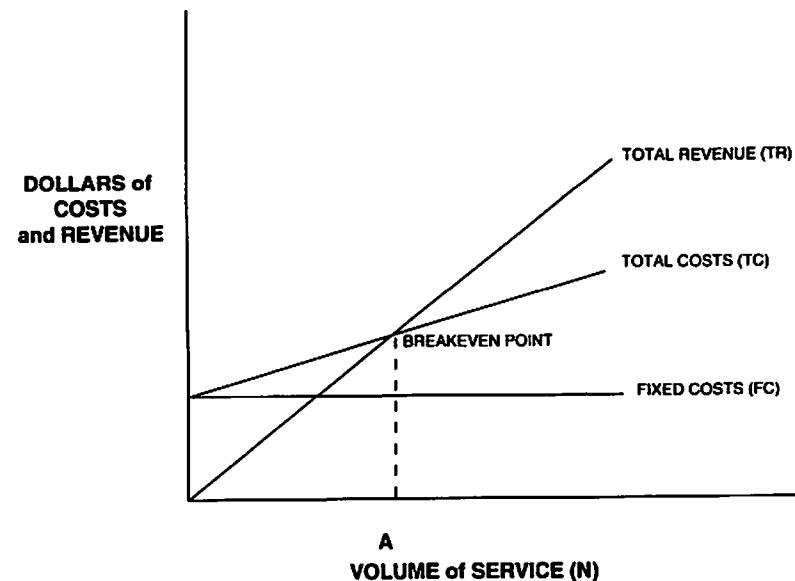
1. Would the proposed new contract with ARGO cover the full costs for the new satellite health center?
2. If not, how many additional enrollees from the community would be required for the health center to break even financially?
3. To break even on the basis of the ARGO contract, what capitated payment should Jefferson negotiate?

An Overview of Break-Even Analysis

A preliminary examination of the requirements for this case suggests that break-even analysis may be an appropriate technique for Jefferson Community Health Plan managers to employ in answering the questions about the proposed new facility and contract with ARGO Industries.

Break-even analysis matches total revenues with total costs as the volume of service increases. Figure 2.1 is a generalized diagram of a break-even chart. Total revenue and total costs are plotted against volume of service. At point A on the diagram, volume of service is such that total revenue and total costs are exactly equal. This is the break-even point, below which the service would operate at a loss and above which the service would be provided at a profit (or with positive

Figure 2.1 Break-Even Chart



net revenue). Note that in this diagram, both costs and revenue are linear and are represented as straight lines. This means that costs and revenue increase by a fixed amount for each unit of service added. This is not always the case, and further discussion of nonlinear functions is included later in the chapter.

Costs associated with break-even analysis will fall into two categories: fixed costs and variable costs. *Fixed costs* are those that are incurred regardless of how much service is provided. They include items such as the capital costs of equipment and facilities, overhead items such as utilities and maintenance, and minimum personnel requirements to operate the facility. *Variable costs* are items of expense that relate to the direct cost of providing care and are expressed as costs per unit of service delivered. Note that in Figure 2.1, fixed costs are plotted as a horizontal line in which the dollar value remains the same regardless of the volume of service. *Total costs* are the sum of fixed costs and variable costs and are plotted as a straight line that increases as the volume of service increases.

The mathematical formulas involved (assuming straight-line cost and revenue functions) are as follows:

$$TR = REV \times N$$

$$VC = COST \times N$$

$$TC = VC + FC$$

where

<i>TR</i>	= total revenue
<i>REV</i>	= revenue generated for each unit of service
<i>N</i>	= the number of units of service provided
<i>VC</i>	= variable costs
<i>COST</i>	= the cost incurred for each unit of service
<i>TC</i>	= total cost
<i>FC</i>	= fixed costs

Model Formulation, Quantification, and Data Requirements

Jefferson Community Health Plan must be able to generate certain data sets in order to compute the break-even point for the proposed new satellite facility. Some of these data elements can be obtained from existing information systems, and others must be estimated or obtained through surveys. The available data include the following:

1. Data from existing information systems: variable costs for operating the new facility, obtained from the cost-accounting system for other units of the health plan:

Supplies and materials	\$15,000 per 100 enrollees
Clinical staff costs	\$76,000 per 100 enrollees
Support services	\$18,000 per 100 enrollees
Contract services	\$48,000 per 100 enrollees
Total variable costs	\$157,000 per 100 enrollees or \$1,570 per enrollee per year
2. Data obtained from estimates:
 - a. Revenue per enrollee based upon preliminary discussions with ARGO \$1,800 per enrollee per year.
 - b. Fixed costs for the new satellite center:

(1) Construction	\$1,800,000
(2) Equipment	\$ 500,000
	\$2,300,000 amortized for ten years =
	\$230,000 per year
(3) Fixed operating costs	\$370,000 per year
Total fixed costs	\$600,000 per year

3. Data obtained from a survey of its employees by ARGO Industries: 1,500 employees are likely to enroll in the Jefferson Plan if the new facility is built.

Note that in this case problem, the data are readily available because the Jefferson Plan had cost-accounting systems in place and could draw on experience from existing units within the Plan. In some cases, health services organizations may not have reliable cost-accounting information systems, and special cost-finding studies might be required before the break-even analysis could be carried out.

Solving the Case Problem

Management analysts at Jefferson now have the necessary data and problem formulation. The solutions requested by management can be computed as follows.

$$\begin{aligned} \text{Total revenue (TR)} &= \$1,800 \times N \\ \text{Fixed costs (FC)} &= \$600,000 \\ \text{Variable costs (VC)} &= \$1,570 \times N \\ \text{Total costs (TC)} &= FC + VC = \$600,000 + \$1,570 \times N \end{aligned}$$

The break-even point will occur when total revenue equals total costs. This is computed by setting $TR = TC$ and solving the equation for N :

$$\begin{aligned} TR &= TC \\ 1,800N &= 600,000 + 1,570N \\ N &= 600,000 / (1,800 - 1,570) \\ &= 600,000 / 230 = 2,609 \text{ enrollees per year} \\ &\quad \text{required to break even} \end{aligned}$$

Note that the general formula for computing the break-even point is

$$N = FC / (REV - COST)$$

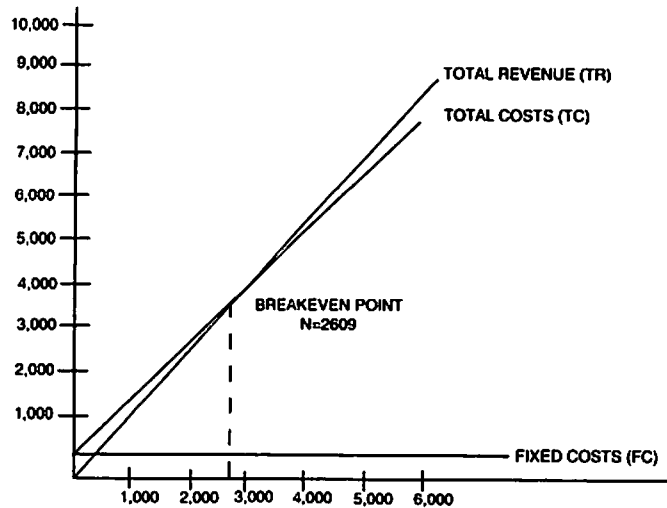
A break-even chart for this case problem is shown in Figure 2.2.

Since ARGO estimates that 1,500 enrollees would sign up, the contract with ARGO alone (at \$1,800 per enrollee) would not be sufficient to operate the facility at a profit. For 1,500 enrollees, the loss is computed as follows:

$$\begin{aligned} TR &= \$1,800 \times 1,500 &&= \$2,700,000 \\ TC &= \$600,000 + (\$1,570 \times 1,500) &&= \$2,955,000 \\ \text{LOSS at 1,500 enrollees} &&&= (\$ 255,000) \end{aligned}$$

To break even at the \$1,800 price, Jefferson would have to attract additional enrollees from other sources in the community. The number

Figure 2.2 Case Problem—Break-Even Chart



organization is pressed into offering deep discounts for services rendered in negotiations with a large purchasing cooperative representing multiple companies in its service area.

Note that in Figure 2.3 there are two break-even points, designated as A and B on the chart. Services would only be profitable on that part of the graph between points A and B.

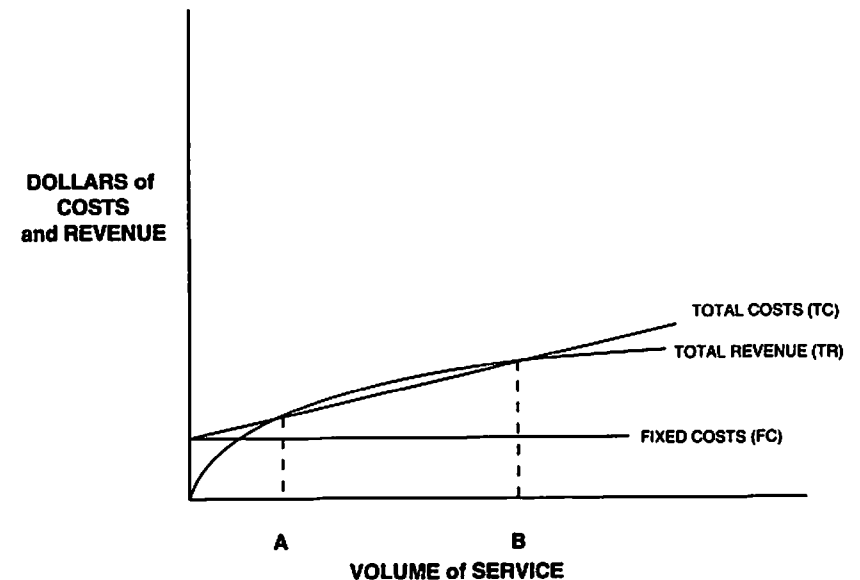
Another common variation on the break-even chart is shown in Figure 2.4. In this situation, total costs follow a pattern known as a step function. This situation could occur when fixed costs remain the same for a certain volume of service and then jump upward when a new threshold level of service occurs.

This often is the case when additional personnel must be added to provide service at different threshold levels. Note that in Figure 2.4, there are five break-even points designated as A, B, C, D, and E. The organization will not reach a level of continuous profit until point E on the diagram is reached.

Description of Available Computer Software

Determination of break-even points requires simple algebraic computation as described in the previous section, "An Overview of Break-

Figure 2.3 Break-Even Chart with Nonlinear Functions



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of additional enrollees required would equal the break-even quantity minus the number from ARGO:

$$2,609 - 1,500 = 1,109 \text{ additional enrollees required}$$

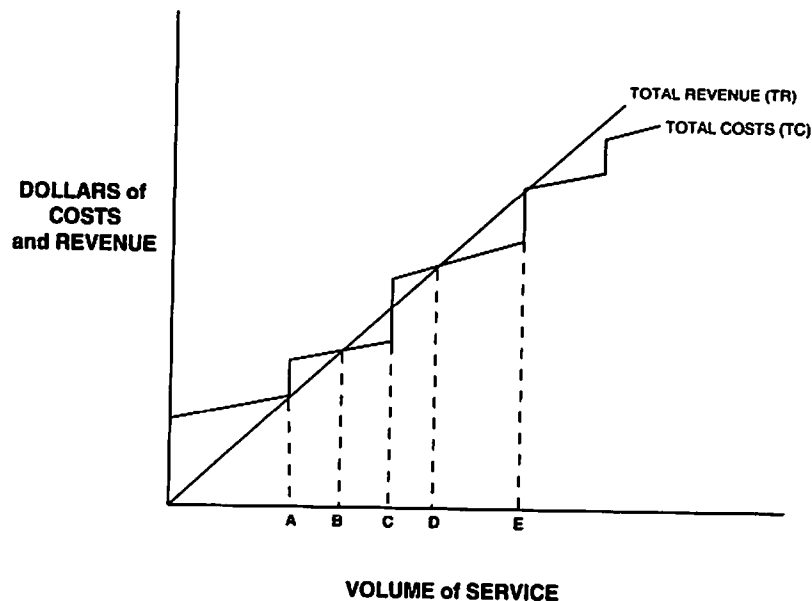
To break even on the basis of the proposed ARGO contract alone, Jefferson would have to negotiate a higher price per enrollee. The required price is computed as follows:

$$\begin{aligned} TC &= TR \\ VC + FC &= TR \\ (\text{COST} \times N) + FC &= REV \times N \\ (1,570 \times 1,500) + 600,000 &= REV \times 1,500 \\ 2,955,000 &= REV \times 1,500 \\ REV &= 2,955,000 / 1,500 \\ &= \$1,970 \text{ per enrollee required for} \\ &\text{break-even with 1,500 enrollees} \end{aligned}$$

Model Variations

Total costs and total revenue are straight-line functions in this example problem. There are situations where this may not be the case. Figure 2.3 is a generalized break-even chart where total costs are linear, but total revenue is a nonlinear function in which revenues start to level off as volume increases. This situation might arise when the health care

Figure 2.4 Break-Even Chart with Cost Step Function



Even Analysis.” No special computer software is needed for carrying out these calculations. However, spreadsheet software packages may be useful in specific applications of break-even techniques as described below.

What-If Analysis

In using break-even analysis to estimate the financial impact of proposed new services or expansion of existing services, managers of health care organizations may wish to use multiple estimates of key variables, including the price to be charged in generating revenue (REV), the variable cost per unit of service (COST), the fixed cost for providing service (FC), or some combination of these.

Spreadsheet software can be a helpful tool in developing a matrix of assumptions and estimates, and comparing the impact of these alternatives on total costs, total revenue, and break-even points. Exhibit 2.1 is a sample spreadsheet showing this type of analysis for the case problem used in this chapter.

Some commonly used spreadsheet and statistical software packages include Lotus 1-2-3, Excel, and @Risk. The names and addresses of software vendors referenced in the text are included in Appendix B.

Exhibit 2.1 Case Problem—Spreadsheet

	A	B	C	D	E	F	G
Notes	Revenue	Cost	Fixed Costs	Break-Even N	Variable Costs	Total Costs	Total Revenue
1	1,800	1,570	600,000	2,608.696	4,095,652	4,695,652	4,695,652
2	2,000	1,570	600,000	1,395.349	2,190,698	2,790,698	2,790,698
3	1,800	1,500	600,000	2,000.000	3,000,000	3,600,000	3,600,000
4	1,800	1,570	500,000	2,173.913	3,413,043	3,913,043	3,913,043

- Notes: 1 = Original case problem
 2 = Change price to \$2,000 per enrollee
 3 = Reduce variable costs to \$1,500 per enrollee
 4 = Reduce fixed costs to \$500,000

Spread Sheet Formulas: Column D = $\frac{C}{A - B}$
 Column E = $B \times D$
 Column F = $C + E$
 Column G = $A \times D$

Analysis, Interpretation, and Application of Results to Management Decisions

As a result of the analysis described above, managers of the Jefferson Community Health Plan have improved information to apply to decisions about the proposed new satellite facility and potential contract with ARGO Industries.

At an initial negotiated capitation rate of \$1,800 per enrollee, revenue from a contract with ARGO would not, by itself, meet the fixed and variable costs of the new satellite center. Jefferson must evaluate the potential ability to attract 1,109 additional enrollees during the first year to break even. Or, as an alternative, Jefferson could attempt to negotiate a higher capitation amount from ARGO, with \$1,970 per enrollee required to break even on the basis of the ARGO contract alone.

Management can now consider several options for additional action:

1. Conduct market research in the community to estimate the potential for additional enrollees if the satellite center is built.
2. Further discussions with ARGO about the potential to increase the capitation amount for employees who would enroll in the Plan.

3. Consideration of the possibility of operating with an initial loss during the first year of operation with a subsidy to come from other sources of revenue or from operating reserves (if any).
4. Combinations of the above three options.

Management could also carry out what-if analysis, as illustrated in Exhibit 2.1, to simulate the impact of potential cost-reducing actions.

Without break-even analysis and consideration of alternative courses of action, as described in this case, Jefferson Community Health Plan would be in the difficult position of making an important strategic decision with inadequate management information.

Case Studies from the Literature

Pharmaceutical Services (Caselova et al. 1985)

R. E. Thompson General Hospital in El Paso, Texas, is a 335-bed county hospital. The Texas Tech University Regional Academic Health Center is located adjacent to it. Ten years ago, a full-time faculty oncologist was hired by the academic health center to implement a clinical pharmacy service in the health center's outpatient oncology clinic with the director of pharmacy at R. E. Thompson.

The pharmacists' role in the program was designed to go beyond the traditional dispensing one. Pharmacists were to have direct involvement in the administration of IV therapies in the oncology clinic on a biweekly basis. The clinics were staffed by a team consisting of two pharmacists, three nurses, two faculty physicians, and a rotating resident physician. The pharmacists provided an array of clinical and distributive services, including patient monitoring and medication storage, preparation of antineoplastic agents, and administration of the clinic.

After a one-year trial period, principles of break-even analysis were used to justify the costs of the program with pharmacy participation. The new service would break even when sales equal expenses, or when there is a no-profit, no-loss operation. When determining the fixed costs of the model, the existing facilities such as building space, clinic fixtures, and examining rooms were excluded. It was assumed that personnel and equipment costs incurred by the academic medical center would have been required regardless of the involvement of the pharmacy department; thus, they too were excluded as fixed costs. Only the fixed and variable costs associated with providing pharmaceutical services were included in the break-even analysis. Because the pharmacy department used existing facilities, expenses for fixed costs were reduced. Bid prices and invoices were used to determine supply costs.

Break-even analysis showed that the pharmaceutical services in the outpatient oncology clinic would break even at 1,153 patient visits. An annual revenue of \$64,308 would have to be generated to break even. The clinic treated 1,162 oncology patients during the one-year trial period. The pharmacy generated annual revenue of \$64,793 and profit of \$485. The program would remain an integral part of R. E. Thompson's pharmaceutical services.

Clearly, the two institutions benefited financially from implementing the new program. The hospital received a cost-effective program believed to reduce liability because of the increased professional handling of neoplastics. Moreover, the involvement of trained hospital pharmacists was beneficial to both outpatients and the clinic staff. The patients benefited from the convenience of receiving chemotherapy on an ambulatory basis and from the health care expertise of a multidisciplinary team of physicians, nurses, and pharmacists.

Nursing Home Occupancy (Goggans 1981)

The Sooner Nursing Home is a 100-bed, long-term care facility operating in the Southwest region of the United States. At the time of this study (1981), the facility operated at 100 percent occupancy. The patient mix was 80 percent Medicaid and 20 percent private pay with a \$24.66 per day revenue charge for both classes of patients. Accordingly, there was a "lid" on the revenue per patient, and the organization was limited to increasing net income through either reducing costs or increasing the number of patients served in the facility.

Break-even analysis was employed to determine the profitability of the facility at different occupancy levels and to examine the financial feasibility of expanding the institution. Most out-of-pocket costs, such as professional salaries, food, and linen, were considered variable since they are a function of activity or patient census. Fixed costs included salaries and wages for full-time personnel, taxes, rent, interest, and depreciation.

The model suggested that the facility needed to generate \$720,000 gross revenue to break even. This could be achieved at an 80 percent occupancy rate. If the owners expanded the facility by 50 percent (to 150 beds), fixed expenses would increase by approximately 40 percent. Variable expenses would decrease about 5 percent as a percentage of revenue, because of economies of scale due to increased capacity. At this level, the facility would need to generate a revenue of \$896,000 at a 66 percent occupancy rate to break even. A net income of \$204,000 would be achieved if the nursing home operated at 100 percent occupancy.

The results of the model provided information to assist management in evaluating options. Management must also consider the time that it may take to achieve the 100 percent occupancy and resultant net income upon expansion. Managerial implications are multifaceted, and a balance between time constraints and financial gains must be achieved.

Additional Reports from the Literature

Logical expansion of a dental practice typically involves the addition of equipment and personnel. However, an analytic assessment of practice needs is necessary before embarking upon any expansion. Caplan (1988) describes the use of break-even analysis to estimate the potential level of profitability derived from the addition of a hygienist and associated profit centers to a dental practice.

Break-even analysis was used to study home- and community-based long-term care services offered in more than two dozen controlled experiments conducted over the last 30 years (Weissert and Cready 1989). The authors found that health care costs for the treatment group averaged only 14 percent more than for the control group across all studies. Because patient benefits were found to be so minimal, they would have to be valued at an exceedingly high rate to break even from a social perspective. However, improved operating efficiency might make cost-accounting break-even an achievable goal. Needed improvements included better targeting of high-risk patients and better utilization controls on home and community care services.

Owens and Neubecker (1992) examined methods of implementing stress thallium cardiac imaging services at a group physicians' office. The hospital involved had three alternatives from which to choose in order to provide the office with an imaging camera: (1) purchasing a new camera, (2) purchasing used equipment, or (3) leasing a new camera. Break-even analysis was used to determine the most financially feasible method without sacrificing the quality of services. Using budgeted income statements, net present value, and the internal rate of return for each method, it was determined that the method of choice, without sacrificing quality of service delivery, was to purchase a used camera.

Carney et al. (1989) employed break-even analysis to examine the adequacy of Medicare reimbursement in covering hospice costs. Hospice costs are high during the first few days after enrollment; therefore, a long period of enrollment is required for per diem reimbursement to cover costs. It was determined that the length of stay for the hospice

to break even is greater than the median length of stay. Generally, the length of time prior to break-even is longer for Medicare recipients than for the total patient population. The authors proposed two changes to alleviate this problem: supplement the per diem rate with an additional fixed amount of reimbursement for each hospice enrollee, or seek higher reimbursement for the first few days of hospice care.

Gapenski (1989) describes a hypothetical situation in which a hospital's single-standing ambulatory clinic has failed to generate the patient volume that it is capable of handling. A break-even analysis may be employed to determine the profitability of three scenarios: (1) expand the clinic's marketing program, (2) extend the clinic's service hours, or (3) extend the clinic's service hours and expand the clinic's marketing program. Analysis of patient revenue per visit, variable costs, and fixed costs reveals that the expanded marketing plan offers the lowest fixed costs and takes the most advantage of excess capacity. Thus, it is the most profitable at any given level of incremental visits.

Discussion Questions

- 2.1 Define *break-even analysis*. When would it be appropriate to use?
- 2.2 Define *fixed costs* and *variable costs*. Give examples of each. How are the two related?
- 2.3 When is a break-even point reached?
- 2.4 Are total costs and total revenue always linear functions? If not, give an example.
- 2.5 What is a *step function*? When does it occur?

Problems

- 2.1 A regional clinical laboratory is considering offering a new test to its clients. The test can be offered in one of two ways. Plan A would use existing equipment but would require more personnel time per test. Plan B would have higher fixed costs because of the need to purchase new capital equipment, but personnel requirements would be lower. Cost and revenue data are as follows:

	Plan A	Plan B
Fixed costs	\$10,000 per year	\$50,000 per year
Variable costs	\$15 per test	\$7 per test
Price (based upon competitor data)	\$30 per test	\$30 per test

Requirement: Prepare a break-even chart and compute the break-even points for both plans. At what volume of service (if any) would Plan B become more profitable?

2.2 A community hospital is considering offering executive physical examinations to local companies as part of its occupational health program. Initial cost and revenue estimates for the new services are as follows:

Fixed costs per year	\$12,000
Variable costs per exam	\$ 140
Price per exam	\$ 250

Requirement: Use a computer spreadsheet program to build a what-if table that computes and displays the answers to the following questions:

- How many exams would be required for the proposed new service to break even?
 - If the price were reduced to \$220 to better meet competition in the area, what would be the new break-even point?
 - If the hospital were to provide the service to only one large company and that company was willing to guarantee 100 exams per year through a contract, what price per exam would the hospital need to charge to break even on the contract?
- 2.3 A regional medical center is considering the expansion of the emergency room to accommodate an expected increase in patient loads. Cost and revenue estimates for the first year of the project are as follows:

Fixed costs (includes five-year amortization of construction costs)	\$250,000
Variable costs per ER visit	\$ 55
Average revenue per ER visit	\$ 165

The medical center estimates that the volume of emergency room activity will increase by 2,000 visits the first year, and this number will grow by 20 percent per year thereafter. The chief financial officer estimates that fixed and variable costs will increase by 5 percent per year due to inflation. However, because of growing regulatory pressure and managed care contracting, average revenue per visit is not expected to increase for the next five years.

Requirement: Use a computer spreadsheet program to build a five-year table of costs and revenue.

- In which year will the facility break even?
 - Compute total profits for the five-year period.
- 2.4 As director of a home health agency, you are in the process of evaluating the possible addition of physical therapy services for your clients. Two options are under consideration. Option A would be to contract with an independent practitioner at a

contract rate of \$60 per home visit. Option B would involve hiring a staff physical therapist with costs estimated as follows:

Automobile lease	\$ 400 per month
Salary and fringe benefits	Range of \$4,000–\$5,000 per month
Medical supplies and gasoline	Range of \$7–\$10 per home visit

Using Medicare reimbursement rates, the average payment for a physical therapy home visit would be \$75 per visit.

Requirement:

- Compute the break-even point for Option B with the most optimistic cost estimates, and with the most pessimistic cost estimates.
- Your best estimate of demand for this service is 90 visits per month. At this level of service, would you choose Option A or B? Why?

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