STUDY UNIT ONE
BUDGETING CONCEPTS
AND FORECASTING TECHNIQUES

Planning, Budgeting, and Forecasting

A budget is a realistic plan for the future that is expressed in quantitative terms. A budget is many tools in one; it is a planning tool, a control tool, a communication tool, and a motivational tool. As such, the area of budgeting, as tested on the CMA exam, is a composite of theory and calculations. Some of the calculations have many steps, thus making budgeting problems among the most-missed questions on the exam. Alternatively, budgeting should not be viewed as a difficult area; the concepts are easy, but you need to pay close attention to detail as you work numerical questions.

This study unit is the **first of two** on **planning, budgeting, and forecasting**. The relative weight assigned to this major topic in Part 1 of the exam is **30%**. The two study units are

Study Unit 1: Budgeting Concepts and Forecasting Techniques
Study Unit 2: Budget Methodologies and Budget Preparation

After studying the outline and answering the questions in this study unit, you will have the skills necessary to address the following topics listed in the ICMA's Learning Outcome Statements:

Part 1 – Section A.1. Budgeting concepts

The candidate should be able to:

a. describe the role that budgeting plays in the overall planning and performance evaluation process of an organization
b. explain the interrelationships between economic conditions, industry situation, and a firm's plans and budgets
c. identify the role that budgeting plays in formulating short-term objectives and planning and controlling operations to meet those objectives
d. demonstrate an understanding of the role that budgets play in measuring performance against established goals
e. identify the characteristics that define successful budgeting processes
f. explain how the budgeting process facilitates communication among organizational units and enhances coordination of organizational activities
g. describe the concept of a controllable cost as it relates to both budgeting and performance evaluation
h. explain how the efficient allocation of organizational resources is planned during the budgeting process

i. identify the appropriate time frame for various types of budgets
j. identify who should participate in the budgeting process for optimum success
k. describe the role of top management in successful budgeting
l. identify best practices guidelines for the budget process
m. demonstrate an understanding of the use of cost standards in budgeting
n. differentiate between ideal (theoretical) standards and currently attainable (practical) standards
o. differentiate between authoritative standards and participative standards
p. identify the steps to be taken in developing standards for both direct material and direct labor
q. demonstrate an understanding of the techniques that are used to develop standards such as activity analysis and the use of historical data
r. discuss the importance of a policy that allows budget revisions that accommodate the impact of significant changes in budget assumptions
s. explain the role of budgets in monitoring and controlling expenditures to meet strategic objectives
t. define budgetary slack and discuss its impact on goal congruence

Part 1 – Section A.2. Forecasting techniques

The candidate should be able to:

a. demonstrate an understanding of a simple regression equation and the measures associated with it
b. define a multiple regression equation and recognize when multiple regression is an appropriate tool to use for forecasting
c. calculate the result of a simple regression equation
d. demonstrate an understanding of learning curve analysis
e. calculate the results under a cumulative average-time learning model and under an incremental unit-time learning model
f. demonstrate an understanding of moving averages, weighted moving averages, and exponential smoothing, and calculate forecasts using these methods
g. demonstrate an understanding of time series analyses, including objectives and patterns, i.e., trend, cyclical, seasonal, and irregular
h. list the benefits and shortcomings of regression analysis, learning curve analysis, and time series analysis
i. calculate the expected value of random variables
j. identify the benefits and shortcomings of expected value techniques
k. use probability values to estimate future cash flows
l. identify the uses of sensitivity analysis
m. perform a sensitivity analysis with different values for the probabilities of the states of nature and/or the payoffs
n. identify the benefits and shortcomings of sensitivity analysis

1.1 BUDGETING CONCEPTS

1. A **budget (profit plan)** is a realistic plan for the future expressed in quantitative terms.
    a. The budget is a **planning** tool.
        1) A budget is a written plan for the future.
        2) Companies that prepare budgets anticipate problems before they occur.
            a) EXAMPLE: If a company runs out of a critical raw material, it may have to shut down. At best, it will incur extremely high freight costs to have the needed materials rushed in. The company with a budget will have anticipated the shortage and planned around it.
        3) A firm that has no goals may not always make the best decisions. A firm with a goal in the form of a budget will be able to plan.
    b. The budget is a **control** tool.
        1) A budget helps a firm control costs by setting cost guidelines.
        2) Guidelines reveal the efficient or inefficient use of company resources.
        3) A manager is less apt to spend money for things that are not needed if (s)he knows that all costs will be compared with the budget.
            a) (S)he will be accountable if controllable costs exceeding budgeted amounts.
        4) Budgets can also reveal the progress of highly effective managers. Consequently, employees should not view budgets negatively. A budget is just as likely to provide a boost to a manager's career as it is to be detrimental.
        5) Managers can also use a budget as a personal self-evaluation tool.
        6) Budgetary slack (overestimation of expenses) must be avoided, however, if a budget is to have its desired effects. The natural tendency of a manager is to negotiate for a less stringent measure of performance so as to avoid unfavorable variances from expectations.
        7) For the budgetary process to serve effectively as a control function, it must be integrated with the accounting system and the organizational structure. Such integration enhances control by transmitting data and assigning variances to the proper organizational subunits.
    c. The budget is a **motivational** tool.
        1) A budget helps to motivate employees to do a good job.
            a) Employees are particularly motivated if they help prepare the budget.
            b) A manager who is asked to prepare a budget for his/her department will work hard to stay within the budget.
        2) A budget must be seen as realistic by employees before it can become a good motivational tool.
        3) Unfortunately, the budget is not always viewed in a positive manner. Some managers view a budget as a restriction.
        4) Employees are more apt to have a positive feeling toward a budget if some degree of flexibility is allowed.

d. The budget is a means of **communication**.

1) A budget can help tell employees what goals the firm is attempting to accomplish.
2) If the firm does not have an overall budget, each department might think the firm has different goals.
3) For example, the sales department may want to keep as much inventory as possible so that no sales will be lost, but the company treasurer may want to keep the inventory as low as possible so that cash need not be spent any sooner than necessary. If the budget specifies the amount of inventory, all employees can work toward the same objectives.

2. **The Budget as a Formal Quantification of Management's Plans**

a. Corporations have goals for market share, profitability, growth, dividend payout, etc. Not-for-profit organizations also have goals, such as increased number of free meals served, lowered recidivism rate among offenders, etc.

1) These goals cannot be achieved without careful planning about the **allocation of resources** and **the expected results**.

b. A **budget** lays out in specific terms an **organization's expectations** about the consumption of resources and the resulting outcomes.

3. **Budgeting's Role in the Overall Planning and Evaluation Process**

a. **Planning** is the process by which an organization sets specific goals for itself and sets about pursuing those goals. Planning is an organization's response to the aphorism "If you don't know where you're going, any path will take you there."

1) The starting point for any organization's planning process is the formulation of its **mission statement**. The mission statement, formulated by the board and senior management, embodies the organization's reason for existing.

a) EXAMPLE: Increase shareholder value through providing global telecommunications services.

2) Next, the organization draws up its **strategic plan** containing the means by which the firm expects to fulfill its stated mission.

a) To a great extent, the strategy is made up of **long-term objectives**, a set of specific, measurable goals.
b) EXAMPLE: Hold a 35% market share of U.S. cell phone users within five years.

3) Once the long-term objectives are in place, the **priorities** of the organization will be clear.

a) Awareness of priorities is crucial for the **allocation of limited resources**.
b) EXAMPLE: How many cell towers, each of which require the outlay of construction and maintenance costs, will provide the optimum amount of coverage.

4) **Short-term objectives** flow directly from the priorities.

a) EXAMPLE: Determine the appropriate number of cell towers needed and where they can feasibly be placed in the Metro Atlanta region.

b. To **evaluate progress** toward success in each of these stages, quantification is necessary. This is the role of the various types of budgets.

1) Not all quantification is in monetary terms. To extend the previous example, although cell towers obviously have a dollar cost, they must be simply counted as well.

2) **Comparing actual results to the budget** allows the organization as a whole to evaluate its performance and managers to do the same on an individual level.

4. **Effects of External Factors on the Budgeting Process**

a. Decisions about a firm's strategy, and in turn about its budget, are dependent on **general economic conditions** and their expected trends and the availability of financial resources.

1) For instance, if the economy is entering a period of lower demand, a manufacturer will not project increased sales. If costs are not changeable, the company may budget losses for the short-term to hold on to market share.

b. **Industry situation** includes the company's current market share, governmental regulatory measures, the labor market, and the activities of competitors.

1) For instance, if input costs are rising in a firm's industry, the budget must reflect that reality; profit margins and cash flows will not be the same as in prior years. Also, a company in, or near, bankruptcy will face a different financial situation than would the market leader.

5. **Budgeting's Role in Formulating and Controlling Short-term Objectives**

a. A company's goal of increasing market share, making a steady dividend payout, etc., can only be achieved through the completion of **incremental steps**.

b. The budget lays out the **specific revenue targets and expense limitations** for each functional area and department of the organization on a month-by-month basis.

1) A budget cannot simply be a lump-sum total for a year. Incremental goals must be achieved each month or week. This is especially true in seasonal businesses, such as agricultural supply.

6. **Characteristics of a Successful Budgeting Process**

a. **Sufficient lead time.** For a budget to be useful, it must be finalized when the fiscal year begins. This often calls for months of preparation, since the overall goals and baseline assumptions must be announced before functional areas and individual departments can begin formulating their numbers.

1) The preparation of a complete organizational budget usually takes several months. A firm with a calendar year-end may start the budget process in September, anticipating its completion by the first of December.

2) The **budget planning calendar** is the schedule of activities for the development and adoption of the budget. It includes a list of dates indicating when specific information is to be provided to others by each information source.

a) Because all of the individual departmental budgets are based on forecasts prepared by others and the budgets of other departments, it is essential to have a planning calendar to integrate the entire process.

b. **Budget manual.** Everyone involved in preparing the budget at all levels must be educated on the detailed procedures for preparing and submitting their part of the overall budget.

1) Because of the number of component departments, budgets must be prepared in a standard format.

a) In addition, all concerned must be informed of the **ultimate goals** that are being pursued and the **baseline assumptions** that have been laid down. A budget may, for example, begin with a blanket mandate to raise revenues by 6.5% or to cut expenses across all departments by 2%.

2) **Distribution instructions** are vital because of the **interdependencies** of a master budget.

a) One department's budget may be dependent on another's, and functional areas must be aggregated from their constituent department budgets. The distribution instructions coordinate these interdependencies.

c. **Buy-in at all levels.** Participative budgeting has a much greater chance of acceptance by those affected and thus of achieving ultimate success than does a budget that is imposed from above.

1) See item 12. on the next page.

7. **Role of Budgets in Measuring Performance against Established Goals**

a. One of the most important reasons for adopting a budget is to provide **guideposts** for the assessment of success or failure on the part of individual managers and functional areas.

b. As the fiscal year progresses, revenues, expenses, and other metrics can be compared to the budget to determine where organizational performance is meeting, lagging, or exceeding expectations.

8. **Role of Budgeting Process in Facilitating Communication among Organizational Units and Enhancing Coordination of Organizational Activities**

a. On a detailed level, the budget informs employees at all levels what objectives the firm is attempting to accomplish.

1) If the firm does not have an overall budget, each department tends to pursue its own objectives without regard to what is good for the firm as a whole. Thus, a budget promotes **goal congruence**.

2) For example, the sales department may want to keep as much inventory as possible so that no sales will be lost, but inventory control may be judged on its turnover rate. If the budget specifies the level of inventory, the two departments have a common framework for decision making and are no longer working at cross purposes.

b. The concrete nature of a budget facilitates **coordination of the activities** of a firm. An example is the purchasing of raw materials.

1) Materials are needed prior to production, but the proper quantity to buy cannot be determined until the projected level of output is established.

a) Thus, a production budget (in units) is a prerequisite to the preparation of a materials purchases budget.

2) Similarly, a direct labor budget is based on how many units are to be produced and how fast the workers are.

a) Labor standards are also complex in that they must consider the impact of the learning curve on productivity.

9. **The Concept of Controllability**
    a. **Controllability** is a key concept in the use of budgets and other standards to evaluate performance. Controllability is the extent to which a **manager can influence** activities and related revenues and costs.
    b. **Controllable costs** are those that are under the discretion of a particular manager. Noncontrollable costs are those to which another level of the organization has committed, removing the manager's discretion.
    c. Controllability can be difficult to isolate because few costs or revenues are under the sole influence of one manager. Also, separating the effects of current management's decisions from those of former management is difficult.
        1) If responsibility exceeds the extent to which a manager can influence an activity, the result may be reduced morale, a decline in managerial effort, and poor performance.
        2) The principle of controllability must be kept in mind when the budget is used as the basis for managerial evaluation.
10. The planning process coordinates the **efficient allocation** of organizational **resources**.
11. **Time Frames for Budgets**
    a. Each phase of the organization's planning cycle has its own budget with an appropriate **time frame**.
        1) **Strategic** plans and budgets most concern senior managers and have time frames of up to 10 years or more.
        2) **Intermediate** plans and budgets most concern middle managers and have time frames of up to 2 years.
        3) **Operational** plans and budgets most concern lower-level managers and generally have time frames of 1 month to 1 year.
12. **Participation in the Budget Process**
    a. Participation in the budget preparation process is **up and down** the organization.
        1) The budget process begins with the mission statement formulated by the **board of directors**.
        2) **Senior management** translates the mission statement into a strategic plan with measurable, realizable goals.
        3) A **budget committee** composed of top management is formed to draft the budget calendar and budget manual. The budget committee also reviews and approves the departmental budgets submitted by operating managers.
        4) **Middle and lower management** receive their budget instructions, draw up their departmental budgets in conformity with the guidelines, and submit them to the budget committee.
13. **The Use of Cost Standards**
    a. Standard costs are **predetermined expectations** about how much a unit of input, a unit of output, or a given activity should cost.
        1) The use of standard costs in budgeting allows the standard-cost system to alert management when the actual costs of production differ significantly from the standard.

b. A standard cost is **not just an average** of past costs but an objectively determined estimate of what a cost should be. Standards may be based on accounting, engineering, or statistical quality control studies.

1) Because of the impact of fixed costs in most businesses, a standard costing system is usually not effective unless the company also has a flexible budgeting system (see item 6.b. in Study Unit 2, Subunit 1).

14. **Theoretical vs. Practical Standards**

a. **Ideal (theoretical) standards** are standard costs that are set for production under optimal conditions. For this reason, they are also called perfection or maximum efficiency standards.

1) They are based on the work of the most skilled workers with no allowance for waste, spoilage, machine breakdowns, or other downtime.
2) Often called "tight" standards, they can have positive behavioral implications if workers are motivated to strive for excellence. However, they are not in wide use because they can have negative behavioral effects if the standards are impossible to attain.
3) Ideal standards are ordinarily replaced by currently attainable standards for cash budgeting, product costing, and budgeting departmental performance. Otherwise, accurate financial planning will be impossible.
4) Ideal standards have been adopted by some companies that apply continuous improvement and other total quality management principles.

b. **Currently attainable (practical) standards** may be defined as the performance that is expected to be achieved by reasonably well-trained workers with an allowance for normal spoilage, waste, and downtime.

1) An alternative interpretation is that practical standards represent possible but difficult-to-attain results.

15. **Authoritative vs. Participative Standard Setting**

a. A purely **top-down (authoritative) approach** to standard setting has the advantage of ensuring total consistency across all functional areas. It is also far less complex and time-consuming than coordinating input from the middle and lower levels.

b. **Participative (grass-roots)** standard setting uses input from middle- and lower-level employees.

1) Participation encourages employees to have a sense of ownership of the output of the process. The result is an acceptance of, and commitment to, the goals expressed in the budget.
2) An imposed budget is much less likely to foster this sense of commitment.

c. Participation also enables employees to relate performance to rewards or penalties.

1) A further advantage of participation is that it provides a broader information base. Middle- and lower-level managers are often far more informed about operational realities than senior managers.

d. Disadvantages of participative standard setting include its cost in terms of time and money. In addition, the quality of participation is affected by the goals, values, beliefs, and expectations of those involved.

1) A manager who expects his/her request to be reduced may inflate the amount.
2) If a budget is to be used as a performance evaluator, a manager asked for an estimate may provide one that is easily attained.

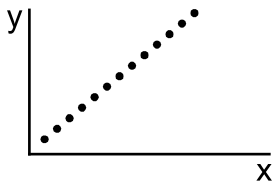
16. **Steps in Developing Standards**
    a. For **direct materials**, there is often a direct relationship between unit price and quality. In establishing its cost standards, a manufacturer must decide whether it will use an input that is
        1) Cheaper per-unit but will ultimately result in higher consumption because of low quality, or
        2) Pricier but allows more efficient usage because of lower waste and spoilage.
    b. For **direct labor**, the complexity of the production process and the restrictions on pay scales imposed by union agreements have the most impact on formulating cost standards. Human resources also must be consulted to help project the costs of benefits.
17. **Activity analysis** identifies, describes, and evaluates the activities that go into producing a particular output. Determining the resources and steps that go into the production process aids in the development of standard costs.
    a. Each operation requires its own unique set of inputs and preparations. Activity analysis describes what these inputs are and who performs these preparations.
        1) Inputs include the amounts and kinds of equipment, facilities, materials, and labor. Engineering analysis, cost accounting, time-and-motion study, and other approaches may be useful.
    b. **Historical data** may be used to set standards by firms that lack the resources to engage in the complex task of activity analysis.
18. **Revisions to the Budget**
    a. Often an organization will find that the **assumptions** under which the budget was prepared undergo **significant change** during the year. A policy must be in place to accommodate revisions to the budget resulting from these changes.
        1) Accommodation of change is a key characteristic of successful budgeting. If such a policy is not in place, managers can come to believe they are being held to a budget that is no longer possible to achieve, and morale can suffer.
    b. Information gained during the year as actual results and variances are reported can be used to help the company take corrective action. These steps make up a control loop:
        1) Establishing standards of performance (the budget)
        2) Measuring actual performance
        3) Analyzing and comparing performance with standards
        4) Devising and implementing corrective actions
        5) Reviewing and revising the standards
19. **The Role of Budgets in Monitoring and Controlling Expenditures**
    a. The initial budget is a planning tool. To monitor how actual performance compares with the budget, budget reports are produced periodically during the year.
        1) The difference between actual performance and a budgeted amount is called a **variance**. Analysis of variances reveals the efficient or inefficient use of company resources (see Study Unit 7, “Cost and Variance Measures”).

20. Participation in developing a budget may result in a **padding** of the budget, also known as budgetary slack.
    a. **Budgetary slack** is the excess of resources budgeted over the resources necessary to achieve organizational goals.
        1) The natural tendency of a manager is to negotiate for a less stringent measure of performance so as to avoid unfavorable variances from expectations.
    b. Management may create slack by overestimating costs and underestimating revenues.
        1) A firm may decrease slack by emphasizing the consideration of all variables, holding in-depth reviews during budget development, and allowing for flexibility in making additional budget changes.
    c. The existence of slack can have both positive and negative effects on the budgeting process. The existence of slack can reduce the planning benefits of a budget since the budget may not be entirely accurate.
        1) For example, a cash budget might show that $500,000 needs to be borrowed this month, whereas the money is not really needed because managers were just being cautious.
        2) Alternatively, the lack of slack may discourage managers from implementing new programs, or might cause managers to avoid routine maintenance when the budget does not show funds available in a particular period.

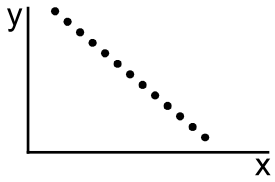
1.2 CORRELATION AND REGRESSION

1. **Forecasts** are the **basis for business plans**. Forecasts are used to project product demand, inventory levels, cash flow, etc.
    a. **Qualitative methods** of forecasting rely on the manager's experience and intuition.
    b. **Quantitative methods** use mathematical models and graphs.
        1) When some factor in the organization's environment is plotted on the X axis, the technique is **causal relationship forecasting**.
        2) When time periods are plotted on the X axis, the technique is **time-series analysis**.
2. **Correlation analysis** is the foundation of any quantitative method of forecasting.
    a. Correlation is the **strength of the linear relationship** between two variables, expressed mathematically in terms of the **coefficient of correlation (r)**. It can be graphically depicted by plotting the values for the variables on a graph in the form of a scatter diagram.
        1) The **value of r** ranges from 1 (perfect direct relationship) to –1 (perfect inverse relationship). The more the scatter pattern resembles a straight line, the greater the absolute value of r.

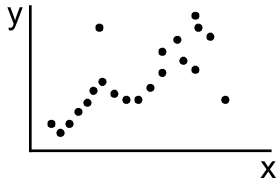
2) **Perfect direct relationship (r = 1)**



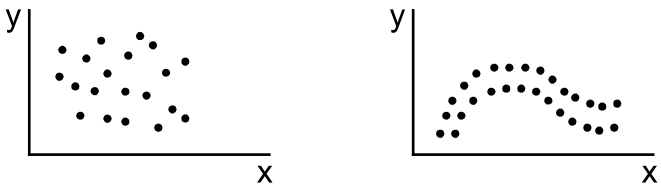
3) **Perfect inverse relationship (r = –1)**



4) **Strong direct relationship (r = 0.7)**



5) **No linear relationship (r = 0)**



a) Note from the right-hand graph of the pair above that a coefficient of correlation of zero does not mean there is no relationship at all between the two variables, only that what relationship they may have cannot be expressed as a linear equation.

b. The **coefficient of determination (r^2)**, or the coefficient of correlation squared, is a measure of how good the fit between the two variables is.

1) Mathematically, the coefficient of determination is the proportion of the total variation in the dependent variable that is accounted for by the independent variable.

2) EXAMPLE: A car dealership determines that new car sales are a function of disposable income with a coefficient of correlation of .8. This is equivalent to stating that 64% ($.8^2$) of the variation of new car sales from the average can be explained by changes in disposable income.

3. **Regression analysis**, also called least-squares analysis, is the process of **deriving the linear equation** that describes the relationship between two variables with a nonzero coefficient of correlation.

   a. **Simple regression** is used when there is one independent variable.

      1) The simple regression equation is, obviously, the algebraic formula for a straight line:

         $$y = a + bx$$

         Where: y = the dependent variable
         a = the y intercept
         b = the slope of the regression line
         x = the independent variable

      2) The best straight line that fits a set of data points is derived using calculus to **minimize the sum of the squares of the vertical distances** of each point to the line (hence the name least-squares method).

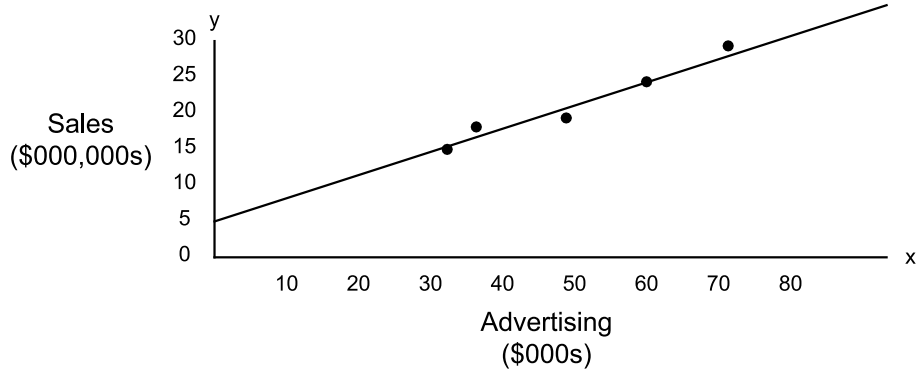
      3) EXAMPLE: A firm has collected observations on advertising expenditures and annual sales.

Advertising ($000s)	Sales ($000,000s)
71	26.3
31	13.9
50	19.8
60	22.9
35	15.1

         a) Solving with the least-squares method reveals that expected sales equal $4.2 million plus 311.741 times the advertising expenditure.

            y = $4,200,000 + 311.741x

         b) The observations are graphed as follows:



         c) The firm can now project the amount it will have to spend on advertising to generate $32,000,000 in sales.

$$\begin{aligned} y &= \$4{,}200{,}000 + 311.741x \\ \$32{,}000{,}000 &= \$4{,}200{,}000 + 311.741x \\ 311.741x &= \$27{,}800{,}000 \\ x &= \$89{,}177 \end{aligned}$$

b. Regression analysis is particularly valuable for **budgeting and cost accounting purposes**.

1) Regression analysis is almost a necessity for computing the fixed and variable portions of **mixed costs** for flexible budgeting. The y-axis intercept is the **fixed portion** and the slope of the regression line is the **variable portion**.

c. **Regression does not determine causality.**

1) Although x and y move together, the apparent relationship may be caused by some other factor. For instance, car-wash sales volume and sunny weather are strongly correlated, but car-wash sales do not cause sunny weather.

d. **Multiple regression** is used when there is more than one independent variable.

1) The example on the previous page relating advertising to sales is clearly unrealistic. Sales are dependent upon more than just advertising expenditures.

2) Multiple regression allows a firm to identify many factors (independent variables), and to weight each one according to its influence on the overall outcome.

$$y = a + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + etc.$$

e. **Assumptions** of the linear regression model.

1) The linear relationship established for x and y is only valid across the **relevant range**. The user must identify the relevant range and assure that (s)he does not project the relationship beyond it.

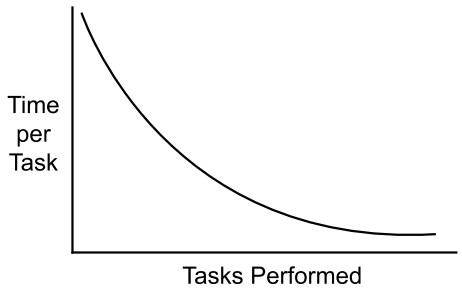
2) Regression analysis assumes that **past relationships** can be validly projected into the future.

3) The distribution of y around the regression line is constant for different values of x, referred to as **homoscedasticity** or **constant variance**. This is known as the *ceteris paribus* assumption, or that all things must remain equal. Thus, a limitation of the regression method is that it can only be used when cost patterns remain unchanged from prior periods.

1.3 LEARNING CURVE ANALYSIS

1. **Learning curve analysis** reflects the increased rate at which people perform tasks as they gain experience.

a. The time required to perform a given task becomes progressively shorter during the **early stages of production**.



b. The curve is usually expressed as a **percentage** of reduced time to complete a task for each **doubling** of cumulative production. The most common percentage used in practice is 80%.

1) The following table illustrates this phenomenon for a product whose first unit takes 100 minutes to produce:

Cumulative Units Produced	Cumulative Average Time per Unit	
1	100	
2	80	(100 × 80%)
4	64	(80 × 80%)
8	51.2	(64 × 80%)
16	40.96	(51.20 × 80%)

2) The time in the right-hand column is an average of all the units produced up to that point. However, with more sophisticated quantitative techniques, a more accurate average can be calculated of the units within each "batch."

a) With the completion of the final batch (units 9 – 16), the average had come down to 40.96%.

b) For it to reach this level from the 51.2% it had reached at the end of the fourth batch (units 5 – 8), the average of the units in the fifth batch alone must have been 30.72% [(40.96% × 2) – 51.2%].

c) CMA candidates need to be alert as to the nature of the question being asked. Sometimes the question might ask, "What is the average time per unit after two units?" From the table above, you can see that the answer is 80. Alternatively, sometimes the question asks, "What is the time to produce the second unit?" The answer would be 60. Since the first unit took 100 minutes and the average for the two units is 80 minutes (a total of 160), then the second unit must have taken only 60 minutes.

2. **Two methods** of applying learning curve analysis are in common use.

a. The **cumulative average-time learning model** projects the reduction in the cumulative average time it takes to complete a certain number of tasks.

b. The **incremental unit-time learning model** projects the reduction in the incremental time it takes to complete the last task.

c. EXAMPLE: A firm determines that 100 minutes of labor is required to complete one unit of product. Assuming an 80% learning curve, the following table illustrates the difference between the two methods.

Learning Curve 80% at Each Doubling		**Cumulative Average-Time Model**		**Incremental Unit-Time Model**	
(A)	**(B)**	**(A) × (B)**		**∑(B)**	**∑ (B) / (A)**
Unit Produced	**Cumulative Average Time per Unit**	**Cumulative Total Time**	**Time Spent on Most Recent Unit**	**Incremental Unit Total Time**	**Average Time Spent on Most Recent Unit**
1	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**
2	**80.00**	**160.00**	**60.00**	**180.00**	**90.00**
3	70.21	210.63	50.63	250.21	83.40
4	**64.00**	**256.00**	**45.37**	**314.21**	**78.55**

1) Note that the 70.21 in the above table was computed using a sophisticated method that is beyond the scope of this book. For this exam, you should know how the 80 and 64 were calculated.

d. The difference between the two methods is clear in the way each calculates total time. Most CMA questions have historically used the **cumulative-average-time method**, and it is often called the "traditional" learning curve model.

3. The limitation of the learning curve in practice is the difficulty in knowing the shape of the learning curve.

   a. There is no question but that the learning curve effect exists, but companies often do not know what percentage they should use in calculations until after it is too late to use the information effectively. As a result, many companies simply assume an 80% learning curve and make decisions based on those results.

1.4 TIME SERIES ANALYSIS

1. **Time series analysis** projects future trends based on past experience (for this reason, it is also called trend analysis).

   a. Changes in business activity **over time** may have several possible components.

      1) **Secular trend** is the long-term change in spite of short-term ups and downs.
      2) **Seasonal variations** are common in many businesses, most obviously retail, which experiences a large spike in activity around the Winter holidays.
      3) **Cyclical fluctuations** are variations in the level of activity tied to the business cycle, i.e., activity in the overall economy.
      4) **Irregular or random variables** are the unexpected happenings that affect businesses (weather, strikes, fires, etc.).

   b. Time series/trend analysis encompasses three main techniques:

      1) **Simple moving average**
      2) **Weighted moving average**
      3) **Exponential smoothing**

2. **Simple moving average** is appropriate when, for instance, the demand for a product is relatively stable and not subject to seasonal variations. The data points are summed and divided by the number of time periods. This process is repeated for successive groups of time periods.

   a. EXAMPLE: A convenience store with a fairly uniform sales history wants to project future gasoline sales. The store has determined that it needs 4 months of data to make a sound projection.

Simple Moving Average

Month	Sales	4-month Cumulative Sales	Divided by: Number of Months	Equals: Next Month's Forecast	Error	Error %
September	$5,480					
October	5,550					
November	5,500					
December	5,520	$22,050	4	$5,513	$53	1.0%
January	5,460	22,030	4	5,508	58	1.1%
February	5,450	21,930	4	5,483	3	0.0%
March	5,480	21,910	4	5,478	(73)	(1.3%)
April	5,550	21,940	4	5,485	(105)	(1.9%)
May	5,590	22,070	4	5,518	(13)	(0.2%)
June	5,530	22,150	4	5,538	(33)	(0.6%)
July	5,570	22,240	4	5,560	50	0.9%
August	5,510	22,200	4	5,550	---	---

3. **Weighted moving average** allows a firm to give each data point a weight indicating its relative importance in determining the outcome.

   a. EXAMPLE: The store's owners decide that weighting the months will give them better projections. Most recent month, 60%; 2 two months ago, 20%; 3 months ago, 10%; 4 months ago, 10%. The results are calculated thusly:

Weighted Moving Average

Month	Sales	January Forecast	February Forecast	March Forecast	April Forecast	May Forecast	June Forecast
September	$5,480	10% $ 548					
October	5,550	10% 555	10% $ 555				
November	5,500	20% 1,100	10% 550	10% $ 550			
December	5,520	60% 3,312	20% 1,104	10% 552	10% $ 552		
January	5,460	*P: $5,515	60% 3,276	20% 1,092	10% 546	10% $ 546	
February	5,450	**E: $ 55	*P: $5,485	60% 3,270	20% 1,090	10% 545	10% $ 545
March	5,480	1.0%	**E: $ 35	*P: $5,464	60% 3,288	20% 1,096	10% 548
April	5,550		0.6%	**E: $ (16)	*P: $5,476	60% 3,330	20% 1,110
May	5,590			(0.3%)	**E: $ (74)	*P: $5,517	60% 3,354
June	5,530				(1.3%)	**E: $ (73)	*P: $5,557
July	5,570					(1.3%)	**E: $ 27
August	5,510						0.5%

*P = Projected
**E = Error

   b. The smaller error percentages indicate improved forecasting.

4. **Exponential smoothing** is a widespread technique for making projections because it **requires less data** be kept on hand than the moving average methods.

   a. Step 1 – **Develop some forecasts** using a more data-intensive method, such as one of the two moving average methods.

   b. Step 2 – **Set the smoothing factor** (alpha) between 0 and 1. The closer it is set to 1, the more weight is put on recent data.

      1) This feature of exponential smoothing makes it especially appropriate for **responding to trends**. For instance, if sales are steadily increasing, the smoothing factor can be set near 1 to give the more recent (i.e., higher) data more weight in the calculation.

   c. Step 3 – **Calculate the next period's forecast.** Each forecast is the sum of two components:

      1) The **current period's actual results** multiplied by the smoothing factor, and
      2) The **current period's forecast** multiplied by the smoothing factor's complement.

   d. The **general formula** for exponential smoothing is therefore

$$F_t = (\alpha)x_{t-1} + (1 - \alpha)F_{t-1}$$

Where: F = the forecast for a period
t = the time period
α = the smoothing factor ($0 < \alpha < 1$)
x = the actual result for a period

e. EXAMPLE: The convenience store is switching to exponential smoothing from weighted moving average to project its unit sales for each month. The forecast of $6,000 for September was thus derived under the old method.

Month	Smoothing Factor	Times: Actual Result	Equals: Actual Result Smoothed	Smoothing Factor Complement	Times: What Was Forecast	Equals: Forecast Smoothed	Next Month Forecast	Error	Error %
September	0.75	$5,480	$4,110	0.25	$6,000	$1,500	$5,610	$ 60	1.1%
October	0.75	5,550	4,163	0.25	5,610	1,403	5,565	65	1.2%
November	0.75	5,500	4,125	0.25	5,565	1,391	5,516	(4)	(0.1%)
December	0.75	5,520	4,140	0.25	5,516	1,379	5,519	59	1.1%
January	0.75	5,460	4,095	0.25	5,519	1,380	5,475	25	0.5%
February	0.75	5,450	4,088	0.25	5,475	1,369	5,456	(24)	(0.4%)
March	0.75	5,480	4,110	0.25	5,456	1,364	5,474	(76)	(1.4%)
April	0.75	5,550	4,163	0.25	5,474	1,369	5,531	(59)	(1.1%)
May	0.75	5,590	4,193	0.25	5,531	1,383	5,575	45	0.8%
June	0.75	5,530	4,148	0.25	5,575	1,394	5,541	(29)	(0.5%)
July	0.75	5,570	4,178	0.25	5,541	1,385	5,563	53	1.0%
August	0.75	5,510	4,133	0.25	5,563	1,391	5,523	--	--

1.5 EXPECTED VALUE

1. **Expected value** is a means of associating a **dollar amount** with each of the possible outcomes of a probability distribution.
   a. The outcome yielding the highest expected value (which may or may not be the most likely one) is the optimal alternative.
      1) The **decision** alternative is under the manager's control.
      2) The **state of nature** is the future event whose outcome the manager is attempting to predict.
      3) The **payoff** is the financial result of the combination of the manager's decision and the actual state of nature.
   b. The expected value of an event is calculated by **multiplying the probability** of each outcome **by its payoff** and summing the products.
      1) EXAMPLE: An investor is considering the purchase of two identically priced pieces of property. The value of the properties will change if a road, currently planned by the state, is built.
         a) The following are estimates that road construction will occur:

Future State of Nature (SN)	Event	Probability
SN 1	No road is ever built.	.1
SN 2	A road is built this year.	.2
SN 3	A road is built more than 1 year from now.	.7

         b) The following are estimates of the values of the properties under each of the three possible events:

Property	SN 1	SN 2	SN 3
Bivens Tract	$10,000	$40,000	$35,000
Newnan Tract	$20,000	$50,000	$30,000

c) The expected value of each property is determined by multiplying the probability of each state of nature by the value under that state of nature and adding all of the products.

		Expected Value
Bivens Tract:	.1($10,000) + .2($40,000) + .7($35,000) =	**$33,500**
Newnan Tract:	.1($20,000) + .2($50,000) + .7($30,000)	**$33,000**

Thus, the Bivens Tract is the better investment.

d) A calculation such as this is often referred to as a **payoff table**.

c. A **criticism** of expected value is that it is based on repetitive trials, whereas many business decisions involve only one trial.

1) EXAMPLE: A company wishes to launch a communications satellite.

a) The probability of launch failure is .2, and the value of the satellite if the launch fails is $0. The probability of a successful launch is .8, and the value of the satellite would then be $25,000,000. The expected value is thus

.2($0) + .8($25,000,000) = $20,000,000

b) But $20,000,000 is not a possible value for a single satellite; either it flies for $25,000,000 or it crashes for $0.

d. The difficult aspect of constructing a payoff table is of course the determination of all possible outcomes of decisions and their probabilities. Thus, a probability distribution must be established.

1) The assigned probabilities may reflect prior experience with similar decisions, the results of research, or highly subjective estimates.

e. The expected value criterion is likely to be adopted by a decision maker who is risk neutral. However, other circumstances may cause the decision maker to be risk averse or even risk seeking.

1) EXAMPLE: A dealer in luxury yachts may order 0, 1, or 2 yachts for this season's inventory.

a) The dealer projects demand for the season as follows:

Demand	Probability
0 yachts	10%
1 yacht	50%
2 yachts	40%

b) The cost of carrying each excess yacht is $50,000, and the gain for each yacht sold is $200,000. The profit or loss resulting from each combination of decision and outcome is thus as follows:

	States of Nature			Expected Value Without Perfect Info.
Decision	**Demand = 0**	**Demand = 1**	**Demand = 2**	**Totals**
Stock 0 yachts	$ 0	$ 0	$ 0	$ 0
Stock 1 yacht	(50,000)	200,000	200,000	175,000
Stock 2 yachts	(100,000)	150,000	400,000	225,000

2) In this example, a risk averse decision maker may not wish to accept the risk of losing $100,000 by ordering two yachts.

3) The benefit of expected value analysis is that it allows a manager to apply scientific management techniques to applications that would otherwise be guesswork.

a) Although exact probabilities may not be known, the use of expected value analysis forces managers to evaluate decisions in a more organized manner. At the least, managers are forced to think of all of the possibilities that could happen with each decision.

2. **Perfect information** is the certain knowledge of which state of nature will occur.

a. The **expected value of perfect information (EVPI)** is the additional expected value that could be obtained if a decision maker knew ahead of time which state of nature would occur.

1) EXAMPLE: The yacht dealer on the previous page would maximize profits if (s)he were able to determine exactly what all potential customers intended to do for the season.

a) The profit that could be obtained with this perfect knowledge of the market is calculated as follows:

States of Nature	Probability	Best Decision Alternative	Payoff	Expected Value
Demand = 0	0.1	0 Yachts	$ 0	$ 0
Demand = 1	0.5	1 Yacht	200,000	100,000
Demand = 2	0.4	2 Yachts	400,000	160,000
				$260,000

b) The difference between this amount and the best choice without perfect information is the EVPI.

Expected value with perfect information	$260,000
Expected value without perfect information	(225,000)
Expected value of perfect information (EVPI)	**$ 35,000**

c) The dealer is therefore not willing to pay more than $35,000 for perfect information about future demand.

1.6 SENSITIVITY ANALYSIS

1. Sensitivity analysis reveals how sensitive expected value calculations are to the accuracy of the initial estimates.

a. Sensitivity analysis is thus useful in determining whether expending additional resources to **obtain better forecasts** is justified.

1) If a change in the probabilities assigned to the various states of nature results in large changes in the expected values, the decision maker is justified in expending more effort to make better predictions about the outcomes.

2) The benefit of sensitivity analysis is that managers can see the effect of changed assumptions on the final objective.

a) For example, in a capital budgeting situation, a proposed investment might promise a return of $10,000 per year and a rate of return of 15%. But that $10,000 is based on an estimate. What management needs to know is how acceptable would the investment be if the return was only $6,000 per year.

b. EXAMPLE: The yacht dealer in the expected value computation illustrated on the previous page is testing different combinations of probabilities. All three of the scenarios depicted here yield the same decision (stock two yachts for the season):

Decision Alternatives	States of Nature	Payoff	Original Probability	Original Expected Value	First Alternative Probability	First Alternative Expected Value	Second Alternative Probability	Second Alternative Expected Value
Stock 0 Yachts	Demand = 0	$ 0	0.1	$ 0	0.5	$ 0	0.333	$ 0
	Demand = 1	0	0.5	0	0.1	0	0.333	0
	Demand = 2	0	0.4	0	0.4	0	0.333	0
				$ 0		**$ 0**		**$ 0**
Stock 1 Yacht	Demand = 0	(50,000)	0.1	(5,000)	0.5	(25,000)	0.333	(16,650)
	Demand = 1	200,000	0.5	100,000	0.1	20,000	0.333	66,600
	Demand = 2	200,000	0.4	80,000	0.4	80,000	0.333	66,600
				$175,000		**$ 75,000**		**$116,550**
Stock 2 Yachts	Demand = 0	(100,000)	0.1	(10,000)	0.5	(50,000)	0.333	(33,300)
	Demand = 1	150,000	0.5	75,000	0.1	15,000	0.333	49,950
	Demand = 2	400,000	0.4	160,000	0.4	160,000	0.333	133,200
				$225,000		**$125,000**		**$149,850**

1) However, the following combination indicates that only one yacht should be stocked:

Decision Alternatives	States of Nature	Payoff	Third Alternative Probability	Third Alternative Expected Value
Stock 0 Yachts	Demand = 0	$ 0	0.1	$ 0
	Demand = 1	0	0.8	0
	Demand = 2	0	0.1	0
				$ 0
Stock 1 Yacht	Demand = 0	(50,000)	0.1	(5,000)
	Demand = 1	200,000	0.8	160,000
	Demand = 2	200,000	0.1	20,000
				$175,000
Stock 2 Yachts	Demand = 0	(100,000)	0.1	(10,000)
	Demand = 1	150,000	0.8	120,000
	Demand = 2	400,000	0.1	40,000
				$150,000

2) Clearly, the more accurately the dealer is able to anticipate demand, the more profit (s)he will make. In this case, the dealer considers it worthwhile to expend further resources gathering more data about market conditions for yachts.

c. A **trial-and-error method** inherent in sensitivity analysis is obviously greatly facilitated by the use of **computer software**.

d. A major use of sensitivity analysis is in **capital budgeting**, where small changes in prevailing interest rates or payoff amounts can make a very great difference in the profitability of a project.

1.7 CORE CONCEPTS

Budgeting Concepts

- A **budget** is a planning tool, a control tool, a motivational tool, and a communication tool. A budget helps communicate to all employees what goals the firm is trying to accomplish. Without a master budget, each department might think the firm has different goals.
- **The budget is a formal quantification of management's plans.** A budget lays out in specific terms an organization's expectations about the consumption of resources and the resulting outcomes.
- The budget lays out the **specific revenue targets** and expense limitations for each functional area and department of the organization on a month-by-month basis. A budget cannot simply be a lump-sum total for a year. **Incremental goals** must be achieved each month or week. This is especially true in seasonal businesses such as agricultural supply.
- **Controllability** is the extent to which a manager can influence activities and related revenues and costs. Controllable costs are those that are under the discretion of a particular manager. Noncontrollable costs are those to which another level of the organization has committed, removing the manager's discretion. The principle of controllability must be kept in mind when the budget is used as the basis for managerial evaluation.
- The planning process **coordinates the efficient allocation** of organizational resources.
- **Participation** in the budget preparation process is up and down the organization.
- **Standard costs** are predetermined expectations about how much a unit of input, a unit of output, or a given activity should cost. The use of standard costs in budgeting allows the standard-cost system to alert management when the actual costs of production differ significantly from the standard.
  - A purely **top-down (authoritative)** approach to standard setting has the advantage of ensuring total consistency across all functional areas. It is also far less complex and time-consuming than coordinating input from the middle and lower levels.
  - **Participative (grass-roots)** standard setting uses input from middle- and lower-level employees. Participation encourages employees to have a sense of ownership of the output of the process. The result is an acceptance of, and commitment to, the goals expressed in the budget.
- Often an organization will find that the assumptions under which the budget was prepared undergo **significant change** during the year. A policy must be in place to accommodate revisions to the budget resulting from these changes.

Forecasting Analysis

- **Forecasts** are the basis for business plans. Forecasts are used to project product demand, inventory levels, cash flow, etc. **Qualitative methods** of forecasting rely on the manager's experience and intuition.
- **Correlation analysis** is the foundation of any quantitative method of forecasting. Correlation is the strength of the **linear relationship** between two variables, expressed mathematically in terms of the coefficient of correlation (r). It can be graphically depicted by plotting the values for the variables on a graph in the form of a scatter diagram. The value of r ranges from 1 (perfect direct relationship) to –1 (perfect inverse relationship).
- The **coefficient of determination** (r^2), or the coefficient of correlation squared, is a measure of how good the fit is between the two variables. Mathematically, the coefficient of determination is the proportion of the total variation in the dependent variable that is accounted for by the independent variable.

- **Regression analysis**, also called **least-squares analysis**, is the process of deriving the linear equation that describes the relationship between two variables with a nonzero coefficient of correlation. Simple regression is used when there is one independent variable. The simple regression equation is, obviously, the algebraic formula for a straight line: $y = a + bx$. Regression analysis is particularly valuable for budgeting and cost accounting purposes.

Learning Curve Analysis

- **Learning curve analysis** reflects the increased rate at which people perform tasks as they gain experience. The time required to perform a given task becomes progressively shorter during the early stages of production. The curve is usually expressed as a percentage of reduced time to complete a task for each doubling of cumulative production. The most common percentage used in practice is 80%. **Two methods** of applying learning curve analysis are in common use:
  - The **cumulative average-time learning model** projects the reduction in the cumulative average time it takes to complete a certain number of tasks. The time spent on the most recent unit is treated as if it were the average for all units so far.
  - The **incremental unit-time learning model** projects the reduction in the incremental time it takes to complete the last task. The time spent on all units so far is accumulated and the average taken.

Time Series Analysis

- **Time series analysis** projects future trends based on past experience (for this reason, it is also called trend analysis). Time series/trend analysis encompasses **three main techniques**:
  - **Simple moving average** is appropriate when, for instance, the demand for a product is relatively stable and not subject to seasonal variations. The data points are summed and divided by the number of time periods. This process is repeated for successive groups of time periods.
  - **Weighted moving average** allows a firm to give each data point a weight indicating its relative importance in determining the outcome.
  - **Exponential smoothing** is a widespread technique for making projections because it requires less data be kept on hand than the moving average methods.
    - Step 1 – Develop some forecasts using a more data-intensive method, such as one of the two moving average methods.
    - Step 2 – Set the smoothing factor (alpha) between 0 and 1. The closer it is set to 1, the more weight is put on recent data.
    - Step 3 – Calculate the next period's forecast. Each forecast is the sum of the current period's actual results multiplied by the smoothing factor, and the current period's forecast multiplied by the smoothing factor's complement.

Expected Value

- **Expected value** is a means of associating a **dollar amount** with each of the possible outcomes of a probability distribution. The outcome yielding the highest expected value (which may or may not be the most likely one) is the optimal alternative. The expected value of an event is calculated by multiplying the probability of each outcome by its payoff and summing the products. A calculation such as this is often referred to as a **payoff table**. A **criticism** of expected value is that it is based on repetitive trials, whereas many business decisions involve only one trial.

Sensitivity Analysis

- **Sensitivity analysis** reveals how sensitive expected value calculations are to the accuracy of the initial estimates. Sensitivity analysis is thus useful in determining whether expending additional resources to obtain better forecasts is justified. If a change in the probabilities assigned to the various states of nature results in large changes in the expected values, the decision maker is justified in expending more effort to make better predictions about the outcomes.