Module 6

Cost theory

Introduction

Firms incur costs when they buy inputs to produce the goods and services that they plan to sell. In this module we examine the link between a firm's production process and its total cost. The firm's cost functions are derived from the optimal input combinations examined in the last module and show the minimum cost of producing various levels of output. In this module we focus on the nature of costs of production consisting of explicit and implicit costs, relevant or opportunity costs, and incremental costs. We, subsequently, examine plant size and economies of scale and scope.

Upon completion of this module you will be able to:

Outcomes

- *examine* the short run and long run cost curves.
- *analyse* the nature of costs and their relevance in managerial decision-making.
- *explain* the importance of the long-run average cost curve.
- *discuss* economies and diseconomies of scale and analyse the factors behind them.
- *explain* the phenomenon of economies of scope vis-a-vis economies of scale.

Terminology

Direct costs:	Costs that can be directly attributed to the production of a particular unit of a given product.
Economies of scale:	Decrease in the unit cost of production as a firm increases all its inputs of production.
Economies of scope:	Produce two or more products together at a lower per-unit cost than for each product separately.
Fixed cost:	Costs do not change when a business changes its quantity of output.

Increasing returns to scale:	The firm's output grows at a rate that is faster than the growth rates of its inputs.
Indirect costs:	Costs that cannot easily and accurately be separated and attributed to individual units of production (except on an arbitrary basis). Also called overhead costs.
Sunk cost:	Cost that is lost forever once it has been paid.
Variable costs:	Costs change when a business adjusts the quantity produced.

Short-run costs

In the short run, just as businesses use fixed and variable inputs, they face corresponding fixed and variable costs. Fixed costs, or total fixed costs, (TFC), do not change when a business changes its quantity of output, since these costs relate to fixed inputs such as machinery and land. Variable costs, or total variable costs, (TVC), in contrast, relate to variable inputs, which change when a business adjusts the quantity produced. The most important variable costs are wages and payments for materials used in production, whereas the typical fixed cost is the cost of machinery. Total cost (TC) is the sum of all inputs, both fixed and variable, and is found by adding fixed and variable costs at each quantity of output.

Costs and production are two sides of the same coin. A firm's total cost reflects its production function, whereas the firm's supply curve, discussed in the earlier modules, is a reflection of its costs relationships.

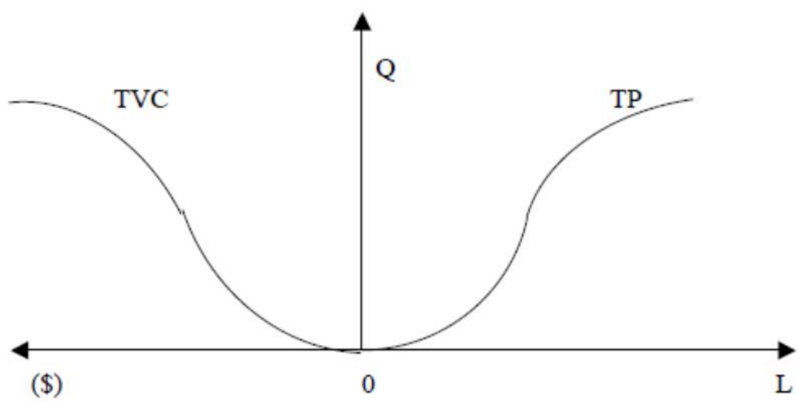
The total variable cost curve

The Total Variable Cost (TVC) curve can be derived from the TP curve simply by multiplying the level of variable inputs by the cost per unit of those inputs and by plotting these cost data against the output level. Suppose that the variable factor unit costs $5 each. Using the data from the total product curve, shown in Table 5-2 in Module 5 partially reproduced below, and multiplying each unit of the variable factor by $5, we can plot the cost of the variable input against the output, Figure 6-1.

Table 6-1 The law of variable proportions

Units of input (L)	Units of output (for $\overline{K} = 2$)
0	0
1	22
2	48
3	80
4	125
5	161
6	188
7	208
8	223

Figure 6-1



Note that the scale on the left-hand side of the horizontal axis is five times that on the right-hand side, so that the TVC curve is a mirror image of the TP curve.

A firm's total cost is the sum of fixed and variable costs.

Average variable and marginal costs

Average variable cost (AVC) is equal to TVC divided by output at every level of Q. That is,

$$AVC = \frac{TVC}{Q} \qquad (1)$$

Average fixed cost (AFC) is equal to TFC divided by output at every level of Q. That is,

$$AFC = \frac{TFC}{Q} \qquad (2)$$

Average total cost (ATC) is equal to TC (TVC + TFC) divided by output at every level of Q. That is,

$$ATC = \frac{TC}{Q} = \frac{TFC + TVC}{Q} = AFC + AVC \qquad (3)$$

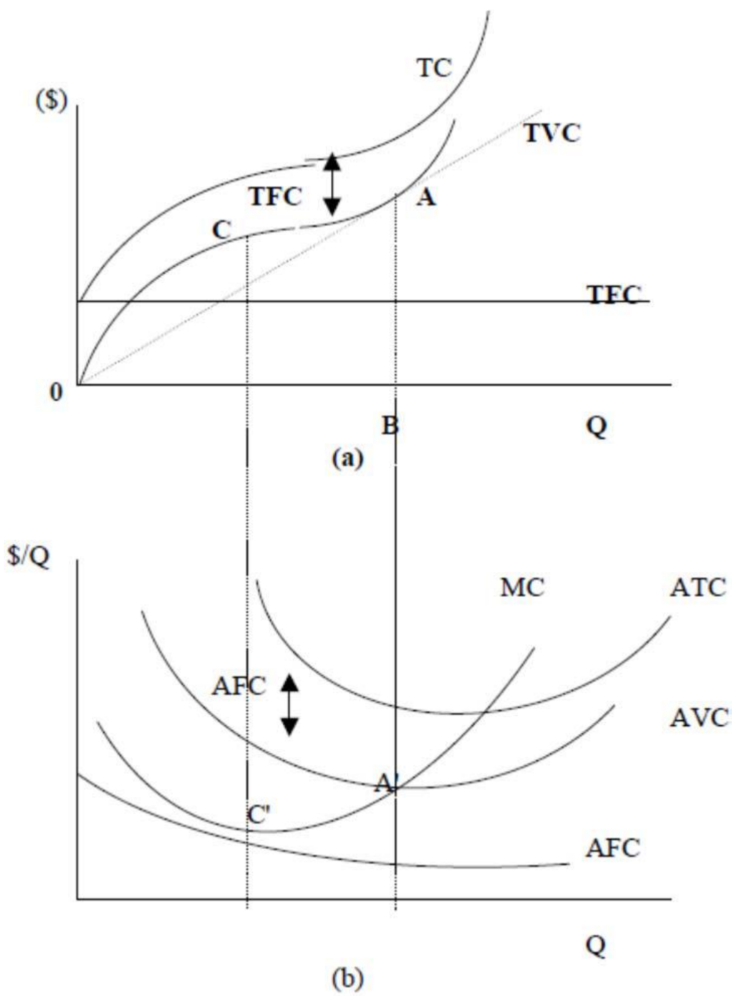
Marginal cost (MC) is equal to the change in total costs caused by a one-unit change in output:

$$MC = \frac{\Delta TC}{\Delta Q} = \frac{\Delta TVC}{\Delta Q} \qquad (4)$$

Note that the fixed cost by definition does not change with the level of output.

In panel (a) in Figure 6-2, we show the TVC curve tipped on its side (rotated 90 degrees to the right), as well as the TC and TFC curve. Note that the difference between TC and TVC is the Fixed costs (TFC). In panel (b), the average and the marginal curves are shown.

Figure 6-2



Note that the AVC for each level is equal to the ratio of the vertical distance from the quantity axis to the TVC curve. Average variable cost at point *A* on the TVC curve, panel (b) Figure 6-2, is equal to the slope of OA (AB/OB), and is shown as point *A′* on the AVC curve, where MC = AVC, below.

It can be seen that the slopes of rays from the origin joining points on the TVC curve become progressively flatter as we begin to move up the TVC curve away from the origin. Thus the AVC, which is equal to the value of these slopes, must fall over this range. MC is, on the other hand, equal to the slope of the TVC curve at each output level. If we were to put tangents against the TVC curve at every output level, we would see that the slopes of these tangents would fall, at first, up to the point of inflection on the TVC curve, point C in panel (a) and would then rise. The point of inflection occurs where the TVC curve changes from convexity to concavity (when viewed from above). The slope of the TVC becomes progressively flatter until point C is reached.

In many production processes the fixed factors are indivisible, in the sense that we must utilise all of the fixed factors or none at all. In the case of a steel mill, for example, the blast furnace is either on or off. Therefore, it must be very inefficient to produce low volumes. In cases like this, over a wide range of output, the higher the level of output, the lower the average cost. Beyond a certain point, however, average cost begins to rise.

In other production processes, however, the plant, or some parts of it, is divisible in the sense that the variable inputs are not obliged to work with the entire plant, but may instead work with a more efficient subset of the plant. In these instances, the firm may be able to work with a reasonably constant input ratio over a wide range of output. The upshot being that, in the former, the average cost curve will be U shaped, as in Figure 6-2, whereas in the latter case, it will be closer to a flat line.

In practice, cost functions may take many forms, but the cubic cost function is the most frequently used function, closely approximating any cost function.

Demonstration problem

The total cost function for a car rental company is

$$TC = 100Q - 3Q^2 + 0.1Q^3.$$

1. What is the equation expressing the AVC curve?
2. What is the equation expressing the MC equation?
3. Determine the level of output that will minimise the AVC curve.
4. Determine the level of output that will minimise the MC curve.

Answer:

1. AVC = TVC/Q. Since TFC is zero, all costs are variable in this case. Hence,

   AVC = 100 – 3Q + 0.1Q^2

2. MC = 100 – 6Q + 0.3 Q^2

3/4. The minimum point of a curve is found by setting its derivate equal to zero:

$$\frac{d(AVC)}{dQ} = -3 + 0.2Q = 0$$

$$\frac{d(MC)}{dQ} = -6 + 0.6Q = 0$$

Therefore, AVC reaches a minimum at Q = (3/0.2) = 15, and MC at Q = (6/0.6) = 10.

Fixed and sunk costs

We now make an important distinction between fixed costs and sunk costs. Recall that a fixed cost is a cost that does not change when output changes. A related concept, called *sunk* cost, is a cost that is lost forever once it has been paid. To be concrete, imagine that you are the manager of a local air commuter company and have paid $100,000 to lease a 70-seater plane for six months. This expense reflects a fixed cost to your firm. The cost is $100,000 regardless of whether you use the plane to carry passengers, use it half empty or use it fully loaded. How much of this $100,000 is a sunk cost depends on the terms of your lease. If the lease does not permit you to recoup any of the $100,000 if you should decide to break your lease in the interim, the entire $100,000 is a sunk cost. You have already incurred the cost, and there is nothing you can do to change it. If the lease states that you will be refunded 50 per cent in the event you do choose to break your lease within the first month, then only $50,000 of the $100,000 in fixed costs is a sunk cost. Sunk costs are thus the amount of these fixed costs that cannot be recouped.

The short-run supply decision

In the short run the firm must incur its fixed costs, since it cannot, by definition, change the input of these factors of production. The firm's variable costs, on the other hand, are discretionary, in the sense that the firm may decide whether or not to incur these costs, since the input of variable factors can be varied all the way back to zero. What induces a firm to incur costs? A firm will set up a plant and incur fixed and variable costs to produce a particular product because it expects to make a profit.

Once committed to its present size of plant, however, the fixed costs of that plant are obligatory in the short run. That is, the firm must incur them because it cannot vary them in the short run, by definition. But variable costs are *discretionary* and should be incurred only if the firm expects revenues at least to cover these variable costs. Suppose that in a particular situation price exceeds average variable cost but is less than the average total cost, meaning that the firm is making a loss. If the firm continues production when P is greater than AVC but less than ATC, there is, for each unit sold, some excess of revenue over variable costs that contributes toward the fixed costs. Therefore, it reduces its losses by continuing to produce when ATC > P > AVC, rather than ceasing production. If it were to cease production, its loss would equal the entire costs, rather than just part of fixed costs.

Long-run costs

As noted earlier, cost behaviour in the short run is an *operating* concept. At any given time, now or in the future, the firm will operate an existing plant that incurs a set of fixed costs. Operational decision-making is, therefore, concerned with minimising variable costs. In contrast, cost behaviour in the long run is a *planning* concept. It is based on the premise that all inputs can be varied and that for each possible output level, there is a least-cost combination of inputs. Therefore, it is possible to construct a plant of optimum size for any desired level of production.

Because of the flexibility afforded in the long run, the firm must begin the planning process by first establishing the technology and production methods that are or will be available for the firm's expansion. The firm is then free to choose the size of the plant.

In Module 5 we defined the long run as the time period during which all inputs are variable. Thus, all costs are variable in the long run (the firm faces no fixed costs). The length of time of the long run depends on the industry. In some service industries, such as dry-cleaning, the period of the long run may be only a few months or weeks. For others that are very capital intensive, such as the construction of a new electricity-generating plant, it may be many years. It all depends on the length of time required for the firm to be able to vary all inputs.

The firm's long-run total cost (LTC) curve is derived from the firm's expansion path and shows the minimum long-run total costs of producing various levels of output. The firm's long-run average and marginal cost curves can then be derived from the long-run total cost curve, below.

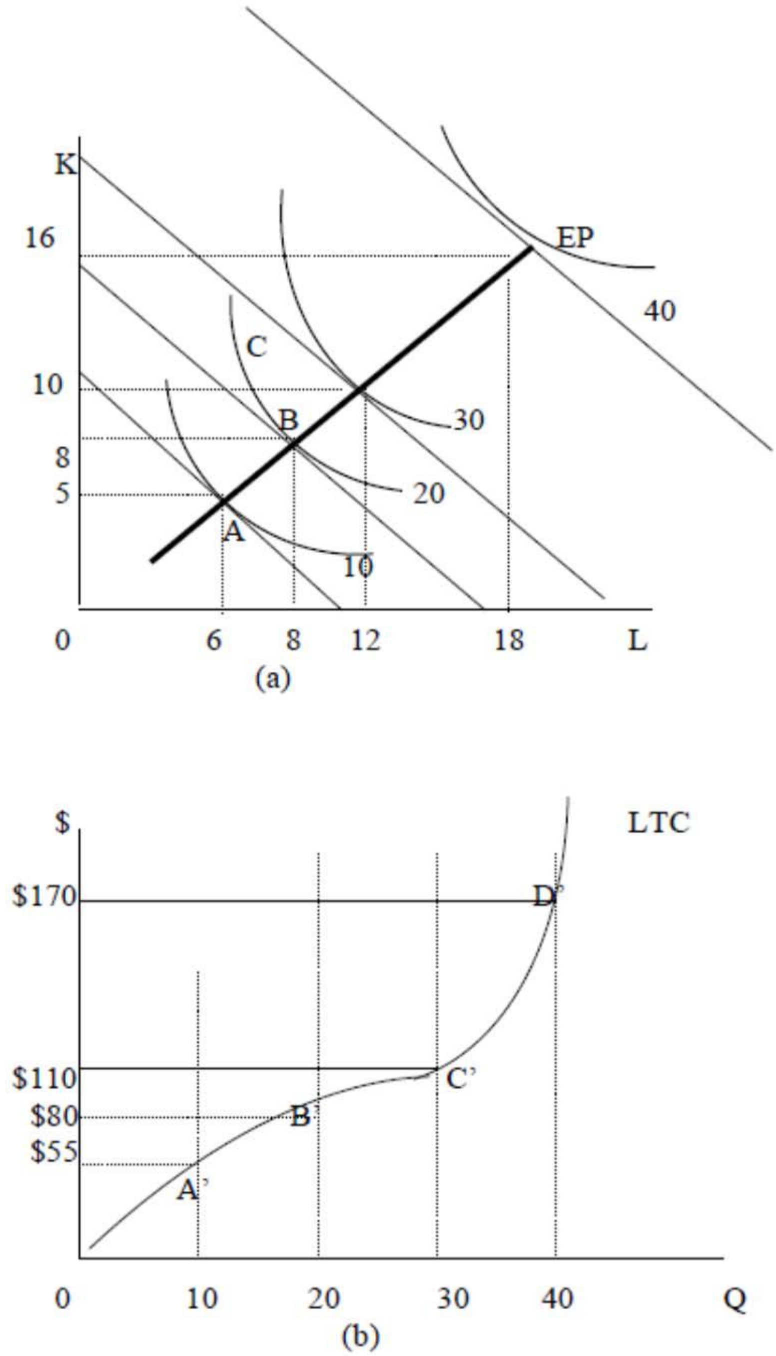
Panel (a) of Figure 6-3 shows the expansion path of the firm. As explained in Module 5, the expansion path shows the optimal input combinations to produce various levels of output. For example, point A shows that in order to produce 10 units of output (10Q), the firm uses six units of labour (6L) and five units of capital (5K). If the wage of labour (P_L) is \$5 per unit and the rental price of capital (P_K) is also \$5 per unit, the minimum total cost of producing 10Q is

$$TC = P_L \times L + P_K \times K$$

$$TC = (\$5)\ (6L) + (\$5)\ (5K) = \$55.$$

This is shown as point A’ in panel (b), where the vertical axis measures total costs and the horizontal axis measures output. From point B on the expansion path in panel (a), we get point B' ($80) on LTC curve in panel (b). Other points on the LTC curve are obtained in a similar fashion.

Figure 6-3

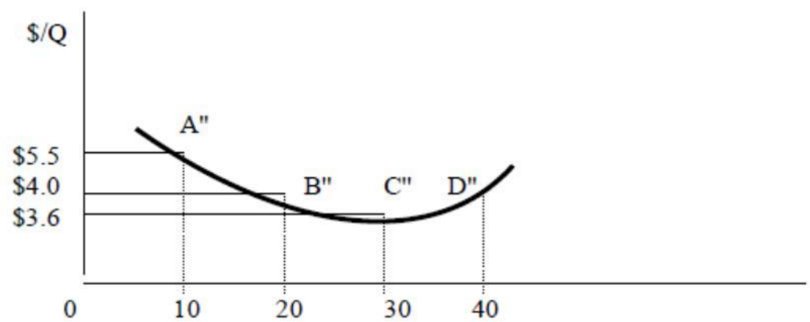


From the LTC curve we can derive the firm's long-run average cost (LAC) curve. LAC is equal to LTC divided by Q. That is,

$$LAC = \frac{LTC}{Q} \tag{5}$$

For example, the LAC to produce 10Q is obtained by dividing the LTC of $55 (point A' on the LTC curve in panel (b) of Figure 6-3) by l0. This is the slope of a ray from the origin to point A' on the LTC curve and is plotted as point A" in Figure 6-4 below. Other points on the LAC curve are similarly obtained. Note that the slope of a ray from the origin to the LTC curve, in Figure 6-3, declines up to point C' and then rises. Thus, the LAC curve, in Figure 6-4, declines up to point C" (4Q) and rises thereafter.

Figure 6-4



From the LTC curve we can also derive the long-run marginal cost (LMC) curve. This measures the change in LTC per unit change in output,

$$LMC = \frac{\Delta LTC}{\Delta Q} \tag{6}$$

The *long-run average cost* (LAC) curve shows the least cost of production for each level when all inputs may be varied. It is the locus of points from various ATC curves which allow each output level to be produced at lowest cost, given the ability to change plant size (that is, to vary continuously the input of capital).

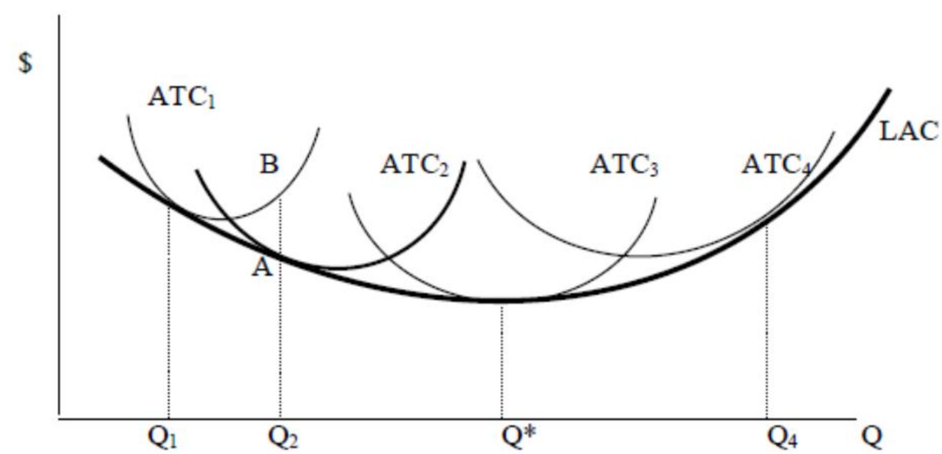
To show this we can proceed by finding a series of ATC curves, one for every level of fixed inputs. Each level of capital (fixed factor) input will give rise to a TP curve, from which we can derive a TVC curve and ultimately obtain the appropriate ATC curve, as we did earlier. This procedure would give us a series of ATC curves, each with a slightly larger capital input level as we move from left to right. As shown in Figure 6-5, the long-run average cost (LAC) curve is the 'envelope curve' of all these short-run curves. A corollary of this is that for any point on the LAC curve there is an ATC curve lying tangent at that point.

The U shape of LAC curve implies that expansion of plant size – each ATC representing a different size with ATC_4 associated with the largest and ATC_1 the smallest plant – results in lower and lower per unit costs until the optimum plant size is reached. This occurs at Q* units of output, corresponding to plant three, where the LAC curve is at its lowest point. Thereafter, further increase in production will require successively larger plants and successively higher unit costs.

As shown in Figure 6-4, LAC is tangent to only one point on each ATC curve. At the optimal plant size, the tangency occurs at the lowest point on both the short-run and long-run average cost curves, shown by ATC_3. For all other plant sizes, the tangency point occurs: (1) to the left of the minimum-cost point on all short-run curves that are to the left of the optimum curve (ATC_3) and (2) to the right of the minimum-cost point on all short-run curves that are to the right of the optimum curve. Therefore, for outputs less than Q*, it is more economical to operate at less than capacity (minimum point of the short run curve), underutilising a plant that is slightly larger than necessary. Therefore, it would be cheaper to produce output Q_2 with a plant designated by ATC_2 than with one represented by ATC_1.

Conversely, at outputs beyond the optimum level Q*, it is more economical to operate at a somewhat higher level than capacity, overutilising a plant with a capacity that is slightly smaller than the required production. Therefore, it is cheaper to produce Q_4 with plant ATC_4 than with ATC_3.

Figure 6-5

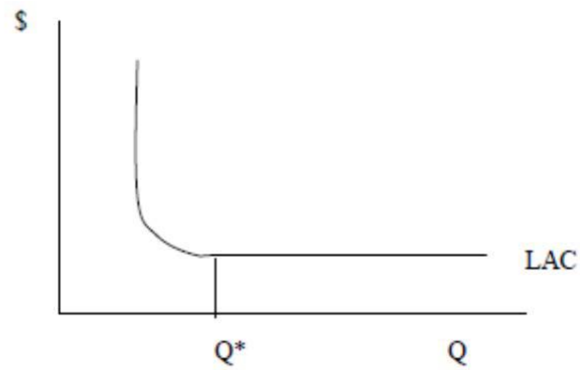


Minimum efficient scale

The shape of the long-run average cost curves of production plants is important not only because it governs cost-efficient plant size but also because it indicates the number of firms that will emerge in an industry. In Figure 6-6, we see that Q* is the level of output that first minimises the long-run average cost of the plant. This is the minimum size or scale of the plant that is cost efficient, when cost-efficient means lowest ATC. Hence we can refer to this plant as the *minimum efficient scale* (MES).

There is evidence that in many industries, the LAC faced by a firm curve may not be U-shaped, as portrayed above, instead it may be L-shaped, as shown in Figure 6-6. Here, once the minimum LAC is reached at a plant with the capacity to produce Q*, successively larger plants can maintain that same minimum LAC. This means that there is a wide range of plant sizes in which there is no particular cost advantage to any one size.

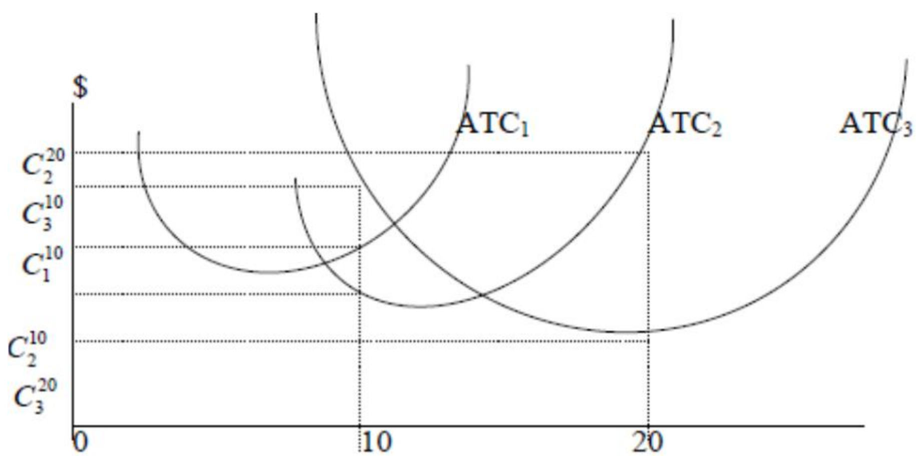
Figure 6-6



Demonstration problem

Suppose that there are three short-run average cost curves as shown in Figure 6-7. Each curve is associated with a different plant size. Which plant can produce 10 units of output most efficiently? Which one can produce 20 units of output most efficiently?

Figure 6-7



Answer:

The smallest plant is ATC_1, the largest plant is ATC_3, and the medium-size plant is ATC_2. If the firm wished to produce 10 units of output, it would choose the medium-size plant at the per unit cost of C_2^{10}, where $C_2^{10} < C_1^{10} < C_3^{10}$. If the firm wishes to produce 20 units, the lowest per unit cost would belong to plant 3, C_3^{20}.

Economies and diseconomies of scale

The term *economies of scale* is defined as the decrease in the unit cost of production as a firm increases all its inputs of production. This phenomenon is illustrated in Figure 6-5, above.

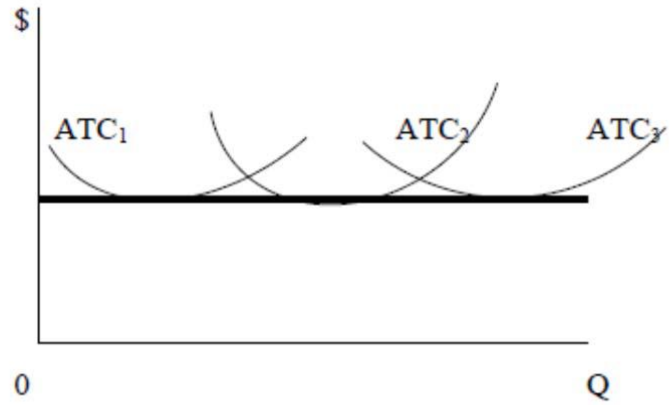
In this figure, we saw that the average total cost curve, labelled ‘Plant 1,’ represented a certain amount of capacity. ‘Plant 2’ represented a greater production capacity because it is positioned to the right of Plant 1. In addition, it is located on a lower level than Plant 1, signifying that over a certain range of output, the larger plant is able to produce greater amounts of output at a lower average cost than the smaller one. ‘Plant 3’ represented still a larger plant than plant 2, and the lowest cost attained at Q*. This implies that between 0 and Q*, an expansion of output allows the firm to produce at a lower long-run average cost. When there are economies of scale, increasing the size of the operation decreases the minimum average cost.

Sometimes ‘economies of scale’ is used interchangeably with the term *increasing returns to scale.* Increasing returns to scale is a long-term phenomenon indicating that the firm’s output grows at a rate that is faster than the growth rates of its inputs. For example, a 100 per cent increase in inputs results in more than 100 per cent increase in output, say 200 per cent. In this case, as the firm expands, the per-unit cost drops. The following are the main causes of economies of scale.

With the final plant expansion, from ATC_3 to ATC_4, the company’s short-run average cost curve not only shifts to the right but also up. This shift reflects *diseconomies of scale*. Since the plant’s output is rising less rapidly than the total cost of input costs, the average cost curve rises as the production of cars continues to increase.

Constant returns to scale usually result when making more of an item requires repeating exactly the same tasks used to produce previous units of output. In objective terms, constant returns to scale occur in a business that expands inputs a given percentage and sees output rise by the same percentage. In terms of Figure 6-8, this implies that the technology in an industry allows a firm to produce different levels of output at the same minimum average cost.

Figure 6-8



Reasons for economies of scale

Economies of scale, also synonymously used as increasing returns to scale or decreasing costs, arise because of technological and financial reasons. At the technological level, economies of scale arise because as the scale of operation increases, a greater division of labour and specialisation can take place, and more specialised and productive machinery can be used. Specifically, with a large-scale operation, each worker can be assigned to perform a repetitive task rather than numerous different ones. This results in increased proficiency and the avoidance of the time lost in moving from one machine to another. At higher scales of operation, more specialised and productive machinery can also be used. For example, using a conveyor belt to unload a small truck may not be justified, but it greatly increases efficiency in unloading a whole train or ship. Furthermore, some physical properties of equipment and machinery also lead to increasing returns to scale. For example, doubling the diameter of a pipeline more than doubles the flow without doubling costs, doubling the weight of a ship more than doubles its capacity to transport cargo without doubling costs, and so on. Thus, per-unit costs decline. Firms also need fewer supervisors, fewer spare parts, and smaller inventories per unit of output as the scale of operation increases.

Besides the above technological reasons for increasing returns to scale or decreasing costs, there are financial reasons that arise as the size of the firm increases. Because of bulk purchases, larger firms are more likely to receive quantity discounts in purchasing raw materials and other intermediate (semi-processed) inputs than smaller firms. Large firms can usually sell bonds and stocks more favourably and receive bank loans at lower interest rates than smaller firms. Large firms can also achieve economies of scale or decreasing costs in advertising and other promotional efforts. For all these technological and financial reasons, the LAC curve of a firm is likely to decline as the firm expands and becomes larger. Furthermore, the indivisible nature of many types of capital equipment may also result in economies of scale. In situations like this, the average cost (per unit) gets to decline as the volume of output produced increases.

Reasons for diseconomies of scale

Diseconomy of scale, also used synonymously as decreasing returns, or increasing costs, arises primarily because as the scale of operation increases, it becomes ever more difficult to manage the firm effectively and coordinate the various operations and divisions of the firm. The number of meetings, paperwork and telephone bills, increase more than proportionately to the increase in the scale of operation and it becomes increasingly difficult for top management to ensure their directives and guidelines are properly carried out by their subordinates. Thus, efficiency decreases and costs per unit tend to rise. Other reasons for diseconomy of scale are disproportionate rise in transportation costs and input market imperfections (for example, wage rates driven up).

Economies of scope

Until now, our analysis of the production process has focused on situations where the firm produces a single output. There are also numerous examples of firms that produce multiple outputs. Honda Motors Co. produces both cars and motorcycles (and many varieties of each); Hewlett Packard produces many different types of computers and printers. While our analysis for the case of a firm that produces a single output also applies to a multi-product firm, the latter raises some additional issues. This section will highlight these concepts.

This way, it is possible for managers to identify cost-saving phenomenon known as *economies of scope*. This occurs when it is possible to produce two or more products together at a lower per-unit cost than for each product separately. A key factor in this form of cost savings is the sharing of a company's fixed cost by multiple products.

Another way that a company can utilise economies of scope is to produce goods or services that require similar skills and experience. For example, when PepsiCo expanded into the snack and fast-food business, it was able to use its background in one type of fast-moving consumer item (soft drinks) to another (chips, tacos and fried chicken). The product development, channels of distribution and marketing know-how are very similar in these two product groups.

In this section, we will assume that the cost function for a multi-product (in this case a two-product) firm is given by $TC(Q_1, Q_2)$, where Q_1, is the number of units produced of product 1 and Q_2, is the number of units produced of product 2. Therefore, the *multi-product cost function,* which itself is derived from a *multi-product production function*, assumes technical efficiency.

In general, economies of scope are present when the joint output of a single firm is greater than the output that can be achieved by two different firms each producing a single product (with equivalent production inputs allocated between the two firms).

Economies of scope is present when

$$TC(Q_1,0) + TC(0,Q_2) > TC(Q_1,Q_2) \quad (7)$$

Assume that the general expression for a multi-product function is captured by a quadratic function as follows:

$$TC(Q_{1,}Q_2) = a + bQ_1Q_2 + Q_1^2 + Q_2^2 \quad (8)$$

where the joint cost of producing both outputs is captured by (bQ_1Q_2). To determine if the economies of scope is present, we first plug in equation (8) to obtain $TC(Q_{1,}0) = a + Q_1^2$ and $TC(0,Q_2) = a + Q_2^2$, and then plug in the results in equation (7):

$$a + Q_1^2 + a + Q_2^2 > a + bQ_1Q_2 + Q_1^2 + Q_2^2$$

or

$$a - bQ_1Q_2 > 0 \quad (9)$$

Therefore, given that a, Q_1, and Q_2 are all positive – a being the fixed cost and Q_1 and Q_2 being the level of production – economies of scope are present if $b < 0$.

Demonstration problem

Does this production function exhibit economies of scale?

$$TC(Q_{1,}Q_2) = 175 - 0.55Q_1Q_2 + 0.2Q_1^2 + 0.2Q_2^2$$

Answer:

Yes, because the coefficient to Q_1Q_2, which is (– 0.55), is negative and therefore, $a + b\,Q_1Q_2 = 175 + 0.55\,Q_1Q_2 > 0$.

The nature of costs

To determine what a cost is, you must begin with the firm's objective. Let's find the seemingly obvious answer to what costs are by focusing on your diapers business. It is conceivable that you started your firm because of an altruistic desire to provide nearby families of infants with diapers. More likely, however, you started your business to make money. Economists normally assume that the goal of a firm is to maximise profit, and they find that this assumption works well in most cases.

What is a firm's profit? The amount that the firm receives for the sale of its output (diapers) is called its total revenue. The amount that your firm pays to buy inputs (fabric, absorbent filler, workers, sewing machines, etc.) is called its total cost. You get to keep any revenue that is not needed to cover costs. We define profit as a firm's total revenue minus its total cost. That is,

$$\text{Profit} = \text{Total revenue} - \text{Total cost} \quad (10)$$

Your objective is to make your firm's profit as large as possible. To see how a firm goes about maximising profit, we must consider fully how to measure its total revenue and its total cost. Total revenue is the easy part: it equals the quantity of output the firm produces times the price at which it sells its output. The measurement of your firm's total cost, however, is more challenging.

Economic versus accounting costs

The data for decision-making with respect to costs typically come not from economists but from accountants. In most cases these data are adequate and appropriate, but in some cases, since they were derived for different purposes, they are less-suitable for direct insertion into economic decision-making procedures. We shall examine several different economic and accounting cost concepts and the relationships between them.

Direct and indirect costs

In the business firm some costs are incurred that can be directly attributed to the production of a particular unit of a given product. The use of raw materials, labour inputs, and machine time involved in the production of each unit can usually be determined. On the other hand, the cost of fuel for heating, electricity, office and administrative expenses, depreciation of plant and buildings, and other items cannot easily and accurately be separated and attributed to individual units of production (except on an arbitrary basis). Accountants speak of the *direct* costs per unit when referring to the separable costs of the first category and of *indirect*, or *overhead*, costs when referring to the joint costs of the second category.

Note that direct and indirect costs do not coincide exactly with the economist's variable cost and fixed cost categories. The criterion used by the economist to divide cost into either fixed or variable is whether or not the cost varies with the level of output, whereas the criterion used by the accountant is whether or not the cost is separable with respect to the production of individual output units. To bring the accounting costs into line with the economic concepts, we must find that part of the indirect or overhead costs that varies with the output level.

Explicit and implicit costs

The accounting process is predominantly concerned with explicit costs. These are costs that actually involve transfer of funds from the firm to another party that had previously supplied some materials or services. These are out-of-pocket expenses in the current time period, since they are an actual cash outflow in payment for resources. Other cost items, however, are implicit costs, in the sense that they do not involve an actual cash outflow in the current time period.

An easy way of remembering the difference between explicit costs and implicit costs is as follows. *Explicit costs* are generally associated with factors that are not owned by the firm. The opportunity cost of those factors, which are not owned by a firm, is simply the price that firm has to pay for them. Each cost requires direct payment of money by firms. Implicit costs, by contrast, are associated with factors that are owned by the firm. When a firm owns machinery, for example, it does not normally have to pay out money to use that machinery. *Implicit costs* are equal to what the factors could earn for the firm in some alternative use, either within the firm or rented out to some other firm.

Demonstration problem

Suppose you give up the opportunity to earn money as a manager of a local posh restaurant in favour of running your own little pizzeria. In preparing an income statement, how would your accountant take your business decision into consideration differently from that prepared by an economist?

Answer:

Your accountant would not count this as a cost of your pizzeria. Because no money flows out of the business to pay for this cost, it never shows up on the accountant's financial statements. An economist, however, would count the forgone income as a cost because it would affect the decisions that you make in your pizzeria business. For example, if your wage as a manager of the local posh restaurant rises from $200 to $300 per day, you might decide that running your own business is too costly and choose to shut down the factory in order to become a full-time manager.

Opportunity costs and accounting costs

As indicated before, there is a fundamental difference between accounting (absolute) cost and opportunity (alternative) cost. *Accounting cost* is the historical outlay of funds for wages and salaries, raw materials, rent, utilities, interest, and so forth. Accounting costs also include estimated periodic reductions in asset valuations, such as depreciation, amortisation, and depletion expense.

Opportunity cost is the cost of forgoing certain opportunities or alternatives in favour of pursuing others. Opportunity cost exists because all resources are scarce. A resource that is used for one purpose cannot be used for something else at the same time. For example, consider a firm that chooses to invest $100,000 in a building instead of buying a $100,000 government Treasury bill. The interest that could have been earned on the bills is a forgone opportunity and therefore an opportunity cost. In the firm's cost analysis, this opportunity cost should be added to the building's explicit cost of $100,000.

Economic versus accounting profits

When most people hear the word profit, they think of accounting profits. *Accounting profit* is the total amount of money taken in from sales (total revenue, or price times quantity sold) minus the dollar cost of producing goods or services. Accounting profits are what show up on the firm's income statement and are typically reported to the manager by the firm's accounting department.

A more general way to define profits is in terms of what economists refer to as economic profits. *Economic profits* are the difference between the total revenue and the total opportunity cost of producing the firm's goods or services. The opportunity cost of using a resource includes both the explicit (or accounting) cost of the resource and the implicit cost of giving up the next-best alternative use of the resource. The opportunity cost of producing a good or service generally is higher than accounting costs because it includes both the dollar value of costs (explicit, or accounting, costs) and any implicit costs.

Implicit costs are very hard to measure and therefore are often overlooked by managers. Effective managers, however, continually seek out data from other sources to identify and quantify implicit costs. Managers of large firms can use sources within the company, including the firm's finance, marketing, and/or legal departments, to obtain data about the implicit costs of decisions. In other instances managers must collect data on their own.

Demonstration problem

What does it cost you to read a book?

Answer:

The answer is that the price you paid the bookstore for a book is an explicit (or accounting) cost, while the implicit cost is the value of what you are giving up by reading the book. You could be studying some other subject or watching TV, and each of these alternatives has some value to you. These alternatives constitute your implicit cost of reading this book; you are giving up this alternative to read a book. The opportunity cost of reading a book is the value of the 'next best' alternative.

Demonstration problem

Suppose you own a building in New York that you use to run a small pizzeria. Food supplies are your only accounting costs. At the end of the year, your accountant informs you these costs were $20,000 and that your revenues were $100,000. What is your accounting profit, and how different would that be from your economic profit?

Answer:

Your accountant would report to you that your profits are $80,000.

However, these accounting profits overstate your economic profits, because the costs include only accounting costs. First, the costs do not include the time you spent running the business. Had you not run the business, you could have worked for someone else, and this fact would be an economic cost not accounted for in accounting profits. To be concrete, suppose you could have worked for someone for $30,000. Your opportunity cost of time would have been $30,000 for the year. Thus, $30,000 of your accounting profits are not profits at all but one of the implicit costs of running the pizzeria.

Second, accounting costs do not account for the fact that, had you not run the pizzeria, you could have rented the building to someone else. If the rent on the building is $100,000 per year, you gave up this amount to run your own business. Thus, the costs of running the pizzeria include not only the costs of supplies ($20,000) but the $30,000 you could have earned in some other business plus $100,000 you could have earned in renting the building to someone else. The economic cost of running the pizzeria is $150,000 – the amount you gave up for your business. Considering the revenue of $100,000, you actually lost $50,000 by running the pizzeria.

Normal and pure profits

Normal profits are earned when total revenues equal total costs, if total costs are calculated to reflect the opportunity costs of *all* services provided. If revenues just equal these costs, then all factors are earning the same in that particular employment as they could earn elsewhere. If revenues exceed these costs, we say that the firm is earning a *pure*, or economic, profit. Remembering that the owners of the firm are the effective suppliers of the services of the land and buildings mentioned, you will see that an economic profit means that the owners of the firm are earning more profit than they could by investing their capital elsewhere. The accounting profit must be adjusted for the opportunity cost of the owned resources – that is, for what the firm would pay for the services of those resources if they were purchased or hired – before the alternative investment possibilities can be assessed. Accounting profit will exceed economic profit if some implicit opportunity costs are not subtracted from revenues.

Incremental cost analysis

Incremental costs are those costs that will be incurred as the result of a decision. Incremental costs are measured by the change in total costs that results from a particular decision. Incremental costs may therefore be either fixed or variable, since a new decision may require purchase of additional capital facilities plus extra labour and materials.

Relevant costs and irrelevant costs

The *relevant costs* for decision-making purposes are those costs that will be incurred as a result of the decision being considered. The relevant costs are, therefore, the incremental costs. Put differently, when a decision has to be made in which cost is a factor, only those costs that will change as a result of the decision are relevant. On the other hand, costs that have been incurred already and costs that will be incurred in the future regardless of the present decision are *irrelevant* costs as far as the current decision problem is concerned. Costs that do not change as a result of the decision are called sunk costs. Since they are not affected by the decision, sunk costs are irrelevant.

For example, a decision to add a second shift of workers would increase relevant variable costs, such as costs of wages, materials, and supplies, but it would not change the cost already sunk into land, buildings, machinery and other fixed assets used in production.

Demonstration problem

Laila, an accounting major at Midtown College, is on a tight budget, so she has kept careful records on the cost of driving her second-hand car. Her records show that when depreciation, interest on her investment (opportunity cost), licence fees, parking fee and insurance are added to her direct operating costs for petrol, oil, tyres and maintenance the total cost comes to $0.50 per kilometre if she drives 10,000 kilometres per year.

Laila wants to drive home for summer holidays, which is a 1000-kilometre round trip. She can't afford the trip unless she takes other students along to share the cost. She notes that the total cost of the trip at $0.50 per mile would be 1,000 x $.50 = $500. This would mean that the pro rata cost for herself and four riders would be $100 each, a sum that neither she nor her equally penniless classmates can afford.

Fortunately, she learned about incremental costs during a course in cost accounting and recognises that her problem is one of short-run decision-making. Her objective is merely to cover the added operating cost of making a 1000-kilometre round trip for which only the direct operating costs for petrol, oil, tyres and maintenance are relevant. According to Laila's record, these costs amount to 12 cents ($0.12) per kilometre.

Answer:

Thus 1,000 kilometres of driving will increase Laila's total cost by 1,000 x $.12 = $120, not $500. If Laila can find four riders willing to pay $30 each, she will get her own transportation for free.

Module summary

Summary

In the short run, we have fixed and variable costs. The shape of the total variable cost curve follows from the law of diminishing returns. The long-run total cost curve is derived from the expansion path and shows the minimum total cost of producing various levels of output when the firm can build any desired scale of plant. A U-shaped long-run average cost curve is based on the assumption that economies of scale prevail at small levels of output and diseconomies of scale prevail at larger levels of output.

The firm's choice of plant size depends on its desired level of output. If demand is predictable with certainty, the plant size chosen is the one that allows the production of the quantity demanded at minimum average cost. If demand is uncertain, the plant size chosen is one that minimises the expected value of average cost, given the probability distribution formed by the meshing of the demand probabilities and the known cost curves at each output level. Choosing plant size on this basis typically means that the firm builds in some excess capacity, which benefits the firm in case of market growth. In this discussion, we also distinguished the relevant from the irrelevant costs, and, economic profit from accounting profits. Finally, we studied the notion of economies of scope.

Assignment

Assignment

1. The manager of a plant calculated the cost at different output levels. The result is in the table below:

Output	Total Cost	Fixed Cost
0	100	100
1	200	100
2	290	100
3	370	100
4	440	100
5	500	100
6	550	100
7	600	100
8	660	100
9	730	100
10	810	100

   Find the variable cost, average total cost, and marginal cost for the different levels of output.

2. The cost function of a firm is as follows: $TC(Q) = 100Q^3 - 30Q^2 + 10Q + 500$

   Find the marginal cost, average cost, average variable cost functions. If the firm produces 10 units of product then what will be the marginal cost, average cost, and total cost?

Assessment

Assessment

1. A newly floated company requires an initial investment outlay of $1 million in land and machinery. Should this cost be considered as sunk cost? Explain why or why not? How is sunk cost relevant to profit-maximisation?
2. A fast food outlet sells sandwiches (Q_1) and chips (Q_2). The manager estimates that the cost of producing Q and Q exhibits a function:

   C(Q,Q) = 200 + 5Q + 10Q – 2QQ

   Will the outlet be more cost efficient if it were to specialise in any of the two products? Is there any cost-complementarities in production?

Assessment answers

1. Whether the total or part of the initial investment outlay is to be considered as sunk cost depends on how value can be salvaged by disposing the land and machinery. If we consider that there will be no salvage value or in other words one hundred per cent depreciation then the total investment should be considered as sunk cost. Otherwise, there will always be some part that can be recovered. The amount that cannot be recovered is the 'sunk cost.'

2. $MC_1 = 5 - 2Q_1$

   $MC_2 = 10 - 2Q_2$

   Therefore cost complementarities exist, since increasing Q_2 will reduce MC of 1, and also increasing Q_1 will reduce MC of 2.

   $C(Q_1,0) + C(0,Q_2) - C(Q_1,Q_2) = 200 + 5Q_1 + 200 + 10Q_2 - 200 - 5Q_1 - 10Q_2 + 2Q_1Q_2 = 200 + 2Q_1Q_2 > 0$

   Therefore economies of scope exists, and thus specialisation in one product will not be beneficial.

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