Lesson-22

Cost Analysis-I

Introduction to Cost

We can look at the business firm from at least two points of view: productivity, inputs, and outputs or outputs and costs. In advanced microeconomics, these two points of view are called "duals." They are equally valid, but they point up different things. They are also opposites from a certain point of view-- the higher the productivity, the lower the costs. By looking at the firm from the point of view of costs, we shift our perspective somewhat, and gain a much more direct understanding of supply.

We also look more directly at the difference between the long and short run. In the short run, we have two major categories of costs:

- Fixed Costs
- Variable Costs

In the long run, however, all costs are variable. Thus, we must study costs under two quite different headings. Costs will vary quite differently in the long run and in the short.

Fixed and Variable Cost

Variable costs are costs that can be varied flexibly as conditions change. In the John Bates Clark model of the firm, labor costs are the variable costs. Fixed costs are the costs of the investment goods used by the firm, on the idea that these reflect a long-term commitment that can be recovered only by wearing them out in the production of goods and services for sale.

The idea here is that labor is a much more flexible resource than capital investment. People can change from one task to another flexibly (whether within the same firm or in a new job at another firm), while machinery tends to be designed for a very specific use. If it isn't used for that purpose, it can't produce anything at all. Thus, capital investment is much more of a commitment than hiring is. In the eighteen hundreds, when John Bates Clark was writing, this was pretty clearly true.

Over the past century, education and experience have become more important for labor, and have made labor more specialized. Increasing automatic control has made some machinery more flexible. So the differences between capital and labor are less than they once were, but all the same, it seems labor is still relatively more flexible than capital. It is this relative difference in flexibility that is expressed by the simplified distinction of long and short run.

Of course, productivity and costs are inversely related, so the variable costs will change as the productivity of labor changes.

Here is a picture of the fixed costs (FC), variable costs (VC) and the total of both kinds of costs (TC) for the productivity example in the last unit:

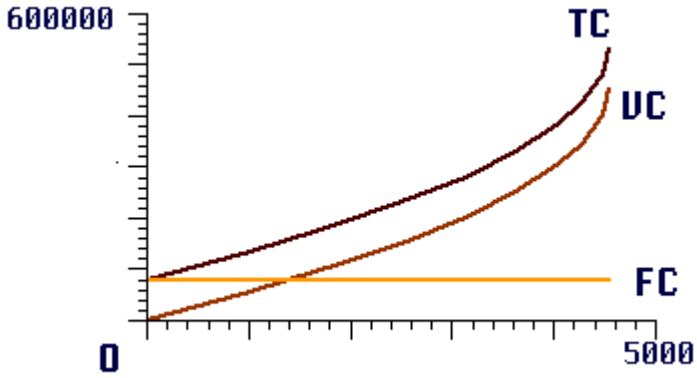

Figure 22.1

Output produced is measured toward the right on the horizontal axis. The cost numbers are on the vertical axis. Notice that the variable and total cost curves are parallel, since the distance between them is a constant number -- the fixed cost.

Opportunity Cost

Connection between the distinctions of fixed vs. variable costs and opportunity costs

In economics, all costs are included whether or not they correspond to money payments. If we have opportunity costs with no corresponding money payments, they are called implicit costs. The implicit costs (as well as the money costs) are included in the cost analysis.

There is some correlation between implicit costs and fixed or variable costs, but this correlation will be different in such different kinds of firms as

A factory owned by an Absentee Investor

This is the easiest case to understand. All of the labor costs to the absentee investor are money costs, including the manager's salary. If the investor has borrowed some of the money he invested in the factory, then there are some money costs of the capital invested -- interest on the loan. However, we must consider the opportunity cost of invested capital as well. The investor's own money that he has used to buy the factory is money that she could have invested in some other business. The return she could have gotten on another investment is the opportunity cost of her own funds invested in the business. This is an implicit cost, and in this case the implicit cost is part of the cost of capital and probably a fixed cost.

A "Mom-and-Pop" Store

A "mom-and-pop" store (family proprietorship or partnership) is a store in which family members are self-employed and supply most of the labor. Typically, "Mom" and "Pop" don't pay themselves a salary -- they just take money from the till when they need it, since it is their property anyway. As a result, there are no money costs for their labor. But their labor has an opportunity cost -- the salary or wages they could make working similar hours in some other business -- and so, in this case, the implicit costs include a large component of variable labor costs.

A large Modern Corporation

The corporation has relatively few implicit costs, but generally will have some. All labor costs will be expressed in money terms (though benefits and bonuses have to be included), since the shareholders don't supply labor to the corporation as "Mom and Pop" do in a family proprietorship. It will pay interest to bondholders and dividends to shareholders. But the dividends aren't really a cost item -- they include profits distributed to the shareholders. Moreover, the typical corporation will retain some profits and invest them within the business, a "plowback" investment. Conversely, shareholders may take a large part of their payout in appreciation of the stock value and plowback investment is one reason for the appreciation.

Thus we would say that the corporation has a net equity value, that is, that the corporation "owns" a certain amount of capital that it invests in its own business (very much like the absentee owner in the first example). This capital has an opportunity cost, and that opportunity cost is an implicit cost. The stockholders, who own the corporation, ultimately receive (as dividends or appreciation) both the opportunity cost of the equity capital and any profit left over after it is taken out.

Unit Cost

Costs may be more meaningful if they are expressed on a per-unit basis, as averages per unit of output. In this way, we again distinguish

Average Fixed Cost (AFC)

This is the quotient of fixed cost divided by output. In the numerical example we are using, when output is 4020 (in the table) fixed cost is 80000, so AFC is 80000/4020=19.9

Average Variable Cost (AVC)

This is the quotient of average cost divided by output. In the example, at an output of 4020 the variable cost is 350000, giving AVC of 350000/4020=87.06.

Average Total Cost (ATC or AC)

This is the quotient of total cost divided by output. In the example, with 4020 of output total cost is 430000, so AC is 430000/4020 = 106.96 = 87.06+19.90.

Here are the average, average variable, and average fixed costs for our example firm.

Table 22.1

Q	AC	AFC	AVC
945	138	85	53
1780	101	45	56
2505	92	32	60
3120	90	26	64
3625	91	22	69
4020	95	20	75
4305	100	19	81
4480	107	18	89
4545	117	18	99

Here are the average cost (AC), average variable cost (AVC) and average fixed cost (AFC) in a diagram. This is a good representative of the way that economists believe firm costs vary in the short run.

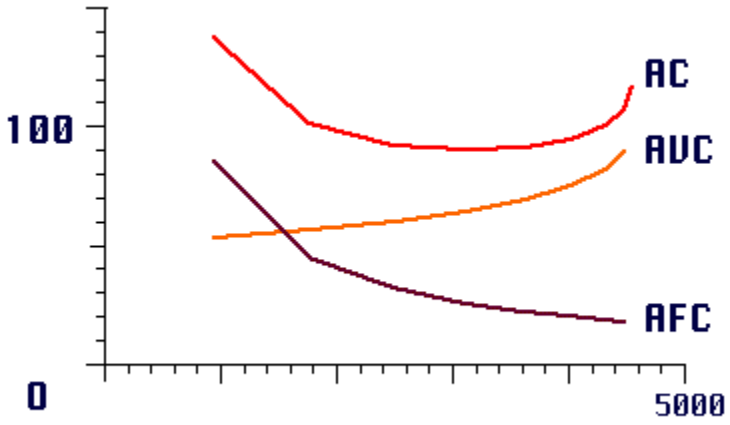

Figure 22.2

Notice how the average fixed costs decline as the fixed costs are "spread over more units of output." For large outputs, however, average variable costs rise pretty steeply. The idea is that with a limited capital plant and thus limited productive capacity -- in the short run

-- costs would rise much more than proportionately to output as output goes beyond "capacity." The average total cost, dominated by fixed costs for small output, declines at first, but as output increases, fixed costs become less important for the total cost and variable costs become more important, and so, after reaching a minimum, average total cost begins to rise more and more steeply.

Marginal Cost

As before, we want to focus particularly on the marginal variation. In this case, of course, it is marginal cost. Marginal cost is defined as

$$MC=\frac{\Delta C}{\Delta Q}$$

As usual, Q stands for (quantity of) output and C for cost, so ΔQ stands for the change in output, while ΔC stands for the change in cost. As usual, marginal cost can be interpreted as the additional cost of producing just one more ("marginal") unit of output.

Let's have a numerical example of the Marginal Cost definition to help make it clear. Total cost is 280000 for an output of 3120, and it is 33000 for an output of 3625. So we have

$$\Delta C = 330000-280000=50000$$

and

$$\Delta Q = 3625-3120=505$$

so that

$$\frac{\Delta C}{\Delta Q} = \frac{50000}{505} = 99.01$$

for a marginal cost of $99.01 for the next unit produced. As usual, this is an approximation, and the smaller the change in output we use, the better the approximation is.

Here is the marginal cost for our example firm, along with output and average cost.

Table 22.2

Output	Average Cost	Marginal Cost
0	0	9.45
945	137.57	52.91
1780	101.12	59.88
2505	91.82	68.97
3120	89.74	81.30
3625	91.03	99.01
4020	94.53	126.58
4305	99.88	175.44
4480	107.14	285.71
4545	116.61	769.23

Here is a picture of marginal cost for our example firm, together with average cost as output varies.

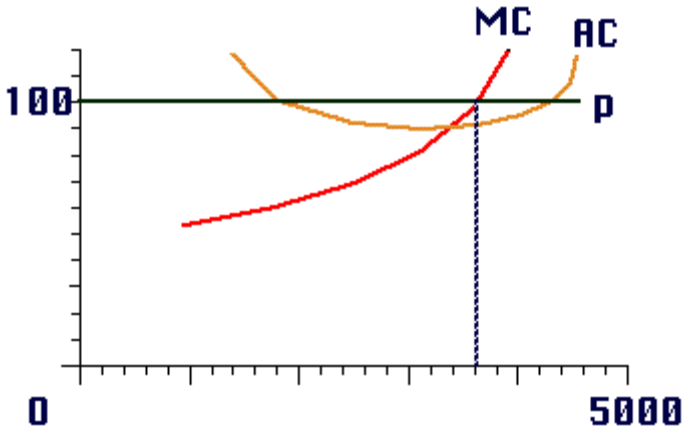

Figure 22.3

As before, the distance to the right on the horizontal axis measures the output produced. The average and marginal costs are on the vertical axis. Average cost is shown by the curve in yellow, and marginal cost in red. Notice how the marginal cost rises to cross average cost at its lowest point.

Maximization of Profit and Cost

We can now give another rule for the maximization of profits. The new rule is really just the same rule as we saw before, only now we state it in terms of price and costs. It is the equimarginal principle in yet another form.

The question is: "I want to maximize profits. How much output should I sell, at the given price?"

The answer is**:** increase output until

p = MC

The point is illustrated by the following table, which extends the marginal cost table in an earlier page to show the price and the profits for the example firm.

Table 22.3

Output	Average Cost	Marginal Cost	price	profit
0	0		100	0
		9.45		

945	137.57		100	-35503.65
		52.91		
1780	101.12		100	-1993.60
		59.88		
2505	91.82		100	20490.90
		68.97		
3120	89.74		100	32011.20
		81.30		
3625	91.03		100	32516.25
		99.01		
4020	94.53		100	21989.40
		126.58		
4305	99.88		100	516.60
		175.44		
4480	107.14		100	-31987.20
		285.71		
4545	116.61		100	-75492.45
		769.23		

Notice how profits are greatest (at 32516.25) when the marginal cost is almost exactly equal to the price of $100. This occurs at an output of 3625, with marginal cost at 99.01. The profit-maximizing output would be very slightly more than 3625.

Supply and Cost

We have discovered the principle of supply for the individual firm.

Remember: what is supply? It is the relation between the price and the quantity that people want to sell. For an individual firm, that is: the relation between the price and the quantity the firm wants to sell.

So we ask: at a given price, how much will a (profit- maximizing) firm want to sell? The answer: enough so that the price is equal to marginal cost. In other words, the marginal cost curve is the supply curve for the individual firm.

Shutdown Point

As long as the firm produces something, it will maximize its profits by producing "on the marginal cost curve." But it might produce nothing at all. When will the firm shut down?

The answer goes a bit against common sense. The firm will shut down if it cannot cover its variable costs. So long as it can cover the variable costs, it will continue to produce.

This is an application of the opportunity cost principle. Just because fixed costs are fixed, they are not opportunity costs in the short run -- so they are not relevant to the decision to shut down. Even if the company shuts down, it must pay the fixed costs anyway. But the variable costs are avoidable -- they are opportunity costs! So the firm will shut down, as it cannot meet the variable (short run opportunity) costs. But as long as it can pay the variable costs and still have something to apply toward the fixed costs, it is better off continuing to produce.

It is important not to confuse shutdown with bankruptcy. They are two different things. If a company cannot pay its interest and debt payments (usually fixed costs), then it is bankrupt. But that doesn't mean it will shut down. Bankrupt firms are often reorganized under new ownership, and continue to produce-- just because they can cover their variable costs, and so the new owners do better to continue producing than to shut down.

Long Run Cost

Thus far we have not considered the long run in cost theory. We will now think a bit about the long run, using the concept of average cost.

We have defined "the long run" as "a period long enough so that all inputs are variable." This includes, in particular, capital, plant, equipment, and other investments that represent long-term commitments. Thus, here is another way to think of "the long run" it is the perspective of investment planning.

So let's approach it this way: Suppose you were planning to build a new plant-- perhaps to set up a whole new company-- and you know about how much output you will be producing. Then you want to build your plant so as to produce that amount at the lowest possible average cost.

To make it a little simpler we will suppose that you have to pick just one of three plant sizes: small, medium, and large. Here's the way they look in a picture:

Here are the average cost curves for the small (AC1), medium (AC2) and large (AC3) plant sizes:

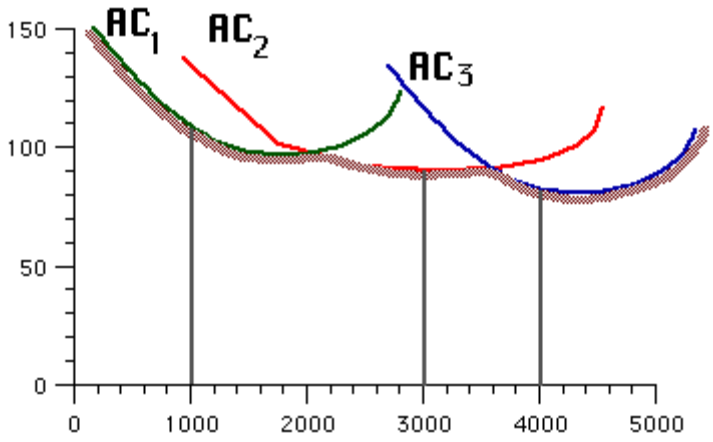

Figure 22.4

If you produce 1000 units, the small plant size gives the lowest cost. If you produce 3000 units, the medium plant size gives the lowest cost. If you produce 4000 units, the large plant size gives you the lowest cost.

Therefore, the long run average cost (LRAC)-- the lowest average cost for each output range -- is described by the "lower envelope curve," shown by the thick, shaded curve that follows the lowest of the three short run curves in each range.

More realistically, an investment planner will have to choose between many different plant sizes or firm scales of operation, and so the long run average cost curve will be smooth, something like this:

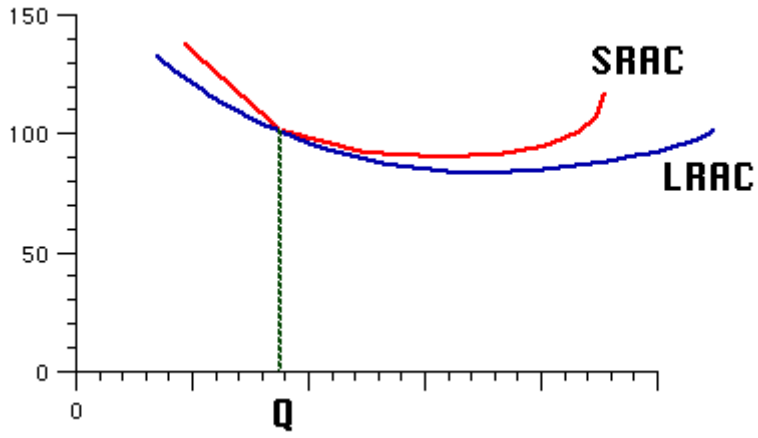

Figure 22.5

As shown, each point on the LRAC corresponds to a point on the SRAC for the plant size or scale of operation that gives the lowest average cost for that scale of operation.

Returns to Scale

In our pictures of long run average cost, we see that the cost per unit changes as the scale of operation or output size changes. Here is some terminology to describe the changes:

Increasing returns to scale = decreasing cost
Average cost decreases as output increases in the long run
Constant returns to scale = constant costs
Average cost is unchanged as output varies in the long run
Decreasing returns to scale = increasing costs
Average cost increases as output increases in the long run

Here are pictures of the average cost curves for the three cases:

Increasing returns to scale = decreasing cost

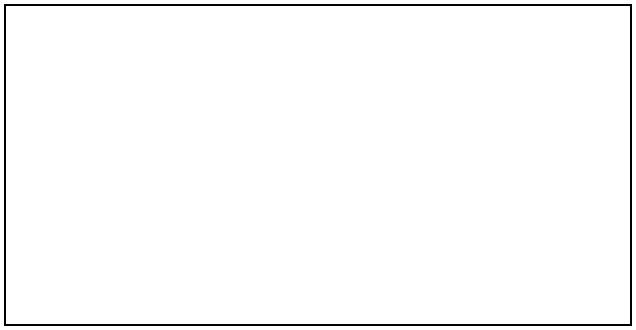

Figure 22.6

Constant returns to scale = constant costs

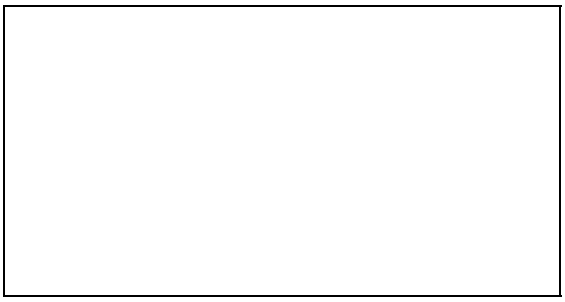

Figure 22.7

Decreasing returns to scale = increasing costs

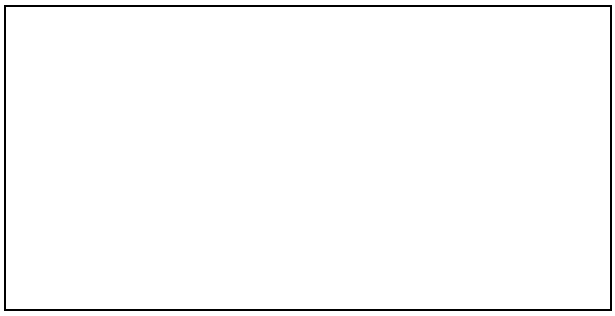

Figure 22.8

Increasing Returns to Scale

Economists usually explain "increasing returns to scale" by indivisibility. That is, some methods of production can only work on a large scale-- either because they require large-scale machinery, or because (getting back to Adam Smith, here) they require a great deal of division of labor. Since these large-scale methods cannot be divided up to produce small amounts of output, it is necessary to use less productive methods to produce the smaller amounts. Thus, costs increase less than in proportion to output-- and average costs decline as output increases.

Increasing Returns to Scale is also known as "economies of scale" and as "decreasing costs." All three phrases mean exactly the same.

Constant Returns to Scale

We would expect to observe constant returns where the typical firm (or industry) consists of a large number of units doing pretty much the same thing, so that output can be expanded or contracted by increasing or decreasing the number of units. In the days before computer controls, machinery was a good example. Essentially, one machinist used one machine tool to do a series of operations to produce one item of a specific kind -- and to double the output you had to double the number of machinists and machine tools.

Constant Returns to Scale is also known as "constant costs." Both phrases mean exactly the same.

Decreasing Returns to Scale

Decreasing returns to scale are associated with problems of management of large, multi-unit firms. Again with think of a firm in which production takes place by a large number of units doing pretty much the same thing -- but the different units need to be coordinated by a central management. The management faces a trade-off. If they don't spend much on management, the coordination will be poor, leading to waste of resources, and higher cost. If they do spend a lot on management, that will raise costs in itself. The idea is that the bigger the output is, the more units there are, and the worse this trade-off becomes -- so the costs rise either way.

Decreasing Returns to Scale is also known as "diseconomies of scale" and as "increasing costs." All three phrases mean exactly the same.

In our examples, the LRAC is (more or less roughly) u-shaped, like this:

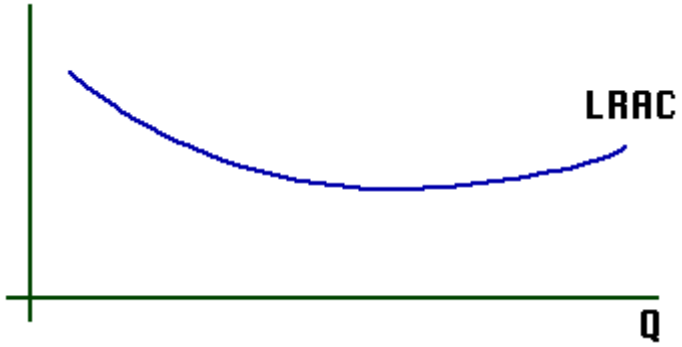

Figure 22.9

The idea is that:

- for small outputs, indivisibilities predominate, and so long run average cost declines with increasing output
- for intermediate outputs, operations can be expanded roughly proportionately, while tendencies to increasing and decreasing costs -- if any -- offset one another.
- for large outputs, the problems of management predominate, and so long run average cost increases with increasing output.

That's reasonable -- but we should recall that it is pretty much a guess, and may or may not apply in a particular case!

Summary

By thinking in terms of cost, rather than productivity, we gain several points of understanding of supply:

- While total and average cost concepts have their uses, the most important in the short run is marginal cost.
- To maximize profits, the firm will increase output to the point where marginal cost equals a given price.
- Therefore, the marginal cost curve is itself the supply curve, in the short run.
- The firm will shut down, however, if it cannot cover its variable cost.
- We may think of the long run as a perspective of investment planning.
- Long run average cost is the "lower envelope" of all the short run average cost curves for different plant or firm sizes.
- We may observe increasing costs, decreasing costs, or constant costs as output increases, in the long run -- or all three, depending on output.