

37 | LABOR DEMAND FOR THE COMPETITIVE FIRM

Purposes: To explain the factors determining a firm's demand for labor.

Computer file: **labcomp198.xls**.

Discussion:

The role of the firm in the standard economics "circular flow" diagram is to be a seller of outputs and a buyer of inputs. Because the firm plays two roles, as a seller of goods and services and as a buyer of inputs, economists can formulate the problem of profit maximization in either of two ways. One is to ask how the firm can choose its quantity of output, and the other is to ask how the firm can choose the amounts of its inputs in order to maximize profits.

How the competitive firm solves the problem of output choice was the topic of problem sets dealing with competitive firms in the short- and long-run. Hidden behind the scenes of that problem was the idea that when the firm chooses the best output, it must also be deciding how much of each input to use. Here we strip back the veil that disguised the input choice, and develop explicit rules for choosing inputs.

Let's start by using the reasoning that led to the firm's rule for choosing output. To maximize profit the firm should produce where marginal revenue equals marginal cost. There may have been some subsidiary details added to the rule, but the basic idea is that the firm wants to produce where the addition to cost is exactly equal to the addition to revenues from producing one more unit. That marginal way of thinking is carried over here, the only difference being that the focus is on how much of an input to use, rather than on how much output to produce.

Consider an apple orchard owner trying to decide what how many workers to hire in order to maximize profits from the sale of apples. The orchard owner calls you in as a consultant to help out in thinking about the issues. Here's what you need to know in order to help:

Following the same logic that we developed in analyzing output choice, you should ask the owner whether hiring an additional worker would add more to the firm's receipts than to its costs. If hiring another worker adds more to receipts than costs, then profits would increase, and the worker should be hired.

Now consider how you might measure these two concepts, the changes in receipts and costs from hiring another worker. If the firm is in perfect competition, a price taker, then finding

the extra cost of hiring another worker, or unit of labor, is easy – it's just the money wage rate (W) that workers must be paid. For example, if the going market wage rate for orchard workers, is \$70 per day, then that is the cost of hiring one more worker.

Thinking about the extra revenue the firm gets from hiring another worker is a bit more complicated. When the firm hires one more worker, some addition to output occurs, which is the marginal product of labor (MP). This is not the extra revenue of the firm, however, just the physical output that results. To find the revenue we must compute how much extra revenue results from the sale of the extra output. If the firm is a perfect competitor, extra units of output can be sold at the going market price (P). So the extra receipts from employing one more worker would be the marginal product of the worker times the price of output. This amount, MP times P, is called the Value of the Marginal Product (VMP) of labor. If we draw the graph of VMP and the amount of labor, the result is called the Value of Marginal Product curve for labor. It shows at each level of labor use the extra receipts to the firm from hiring another unit of labor.

The Law of Diminishing Returns says that the marginal product of labor must eventually decline. This means that as more workers are hired the amount added to output from each one hired becomes less and less.

Here's an example. Suppose at the current level of employment of, say, 150 workers, the marginal product of labor is 10 bushels per worker per day. And suppose that apples sell for \$8.00 per bushel. Then the Value of the Marginal Product of labor is 10 bushels per worker times \$8.00 per bushel, or \$80 per worker. If the wage rate is \$70 per worker per day, then another worker would add more to the firm's receipts (\$80) than it adds to costs (\$70), and more workers should be hired.

Only if the orchard hires workers to the point at which VMP equals W would it be maximizing profits. We call the profit maximizing level of employment the firm's demand for labor. In the case of perfectly competitive firms, the demand curve for labor corresponds exactly to the firm's VMP curve. Neat result!

Tip: Notice that, in competition, the rule for hiring workers ($VMP = \text{wage}$), is very much like the rule for choosing output ($MC = P$). The difference is that the hiring rule is framed in terms of changing labor, while the output rule focuses on just that, output. On careful examination, these rules are actually equivalent ways of looking at the same thing. Since VMP equals $MP \times P$, the labor rule can be written as $P = W/MP$. But W/MP is just the marginal cost of output – check out the units of measurement.

This analysis gives economists insight into how the demand for labor is determined. On the output side, the technology, through the determination of the marginal products, and the price of output are the crucial factors. On the input side, the wage rate is central. So changes in technology and output price, because they change the Value of Marginal Product, coupled with changes in the money wage, are all you need to know to determine labor demand.

Tip: The demand for labor is sometimes called a *derived demand*. This is because labor is not demanded for its own sake, the way you would demand pizza or wine, but because there is an ultimate demand for goods produced with labor. In a sense, the demand for labor is dependent on or derived from the demand for goods.

Answering the questions

The problem set steps you through the process of understanding the underlying factors in labor demand. It begins with your visit to a hypothetical apple orchard where the owner is trying to figure out how much labor to employ. The answer, of course, is the level of employment where $VMP = W$. It goes on to examine a couple of very simple policy exercises involving the effects of technical change and labor training programs on labor demand.

Hints and tips:

- 1) Finding labor demand means finding the level of labor use where $VMP = W$. Use Goal Seek to find the level of labor use where $(VMP - W)$ equals zero.
- 2) The demand for labor curve in this case *is* the Value of Marginal Product curve.
- 3) Two things can cause the demand curve for labor to shift, changes in the output price and changes in the technology.
- 4) Changing the money wage moves you along the demand curve for labor.
- 5) If perfect competition doesn't hold, for example, because there is monopoly in the output market, then things become somewhat more complicated, and the above choice rule won't apply. Or if there is more than one variable input, perhaps because the firm can also change capital, or there are several different kinds of labor with different productivities and wages, then things also become more complicated, and the VMP curve will not correspond exactly to the firm's demand for labor curve. But these are details that need not detract from the central point that firms have demand curves for labor, and those demand curves depend on technology and prices.

MATH MAVEN'S CORNER: The marginal product of labor function is $MP = (a - bL)T$, where L is the level of labor use, T is the technology index, and a and b are parameters that vary randomly for each version of the problem set.

The Law of Diminishing Returns requires that b be positive over the relevant range of choice, so that the marginal product function is negatively sloped.

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Questions

- 1) You are visiting the proprietor of a local apple orchard. The owner tells you that he is currently employing 100 workers to maintain the orchard and pick the fruit. When the proprietor hired his one-hundredth worker (as opposed to hiring the 99th), how much was output increased as a result?
- 2) Make sure all variables are at their baseline values. When the orchard owner hired his one-hundredth worker, by how much did his receipts from sales change?
- 3) Suppose the money wage of orchard workers is \$60 per day. What is the cost of the owner hiring the last (one-hundredth) worker?
- 4) What was the change in profits to the orchard owner due to hiring that last (one-hundredth) worker?
- 5) The owner then admits to you that he is considering changing the number of people he hires. Should he change the number he hires? (Enter "yes" or "no".)
- 6) You admit to the owner that you are an economics student, and can actually advise him on the exact number of workers he should be hiring. How many workers should he be employing?
- 7) And as another way of putting the last question, how many workers should the orchard owner DEMAND?
- 8) Now suppose the wage rate falls to \$50 per day. What's the firm's DEMAND for labor?
- 9) And finally, if the wage falls to \$20 per day, what's the firm's DEMAND for labor?

[THE POINT: The value of marginal product curve IS the firm's demand curve for labor in this case. Changes in the wage rate move you along the demand (VMP) curve.]

- 10) For this question make sure that all variables are set to their baseline values and the wage rate is \$50 per day. Now suppose that the orchard owner discovers that the price of apples rises to \$12 per bushel. What is the level of labor demand with the higher price of apples?

[THE POINT: An increase in the price of the firm's output causes its demand (VMP) curve to shift.]

11A) Again, set all variables to their baseline values, and set the wage rate to \$50 per day. Now suppose that the orchard owner tells you about a new technology that has become available for orchard management. [Go on to 11B.]

11B) The result of adopting the new methods would be to raise the marginal product of labor for the orchard. To see the effect of the new technology, set the technology index to 1.2. What is the change in labor demand compared to the old technology?

[THE POINT: An improvement in technology raises the demand for labor, leading to an increase in employment.]

12A) Set all variables to their baseline values, and set the wage rate to \$50 per day. You talk with the orchard owner about his plan to provide on the job training sessions for his workers. He thinks that the training will cause the marginal product of labor in his firm to rise. [Go on to 12B.]

12B) Actually the training program will raise the technology index to 1.1. Make a prediction about the effect of the training program on the firm's employment. How many MORE workers will the owner hire?

[THE POINT: Training will increase the demand for labor if it raises the marginal product of labor.]