Lecture 6

The Production Process: The Behavior of Profit-Maximizing Firms

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Principles of Microeconomics

Intro to Firm Behavior

- **<u>production</u> – process by which inputs are combined, transformed, and turned into outputs**
- **<u>firm</u> – person or a group of people that produce a good or service to meet a perceived demand**
- **we'll assume that firms' goal is to <u>maximize</u> <u>profit</u>**

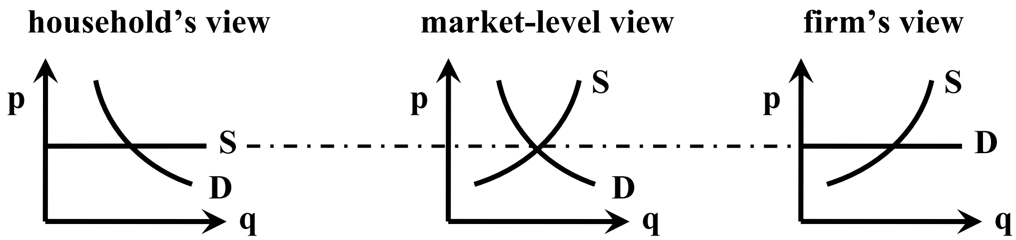
Perfect Competition

- **many firms, each small relative to overall size of the industry, producing homogenous (virtually identical) products**
- **no firm is large enough to have any control over price**
- **new competitors can freely enter and exit the market**

Competitive Firms are Price Takers

- **firms have no control over price**
- **price is determined by *<u>market</u>* supply and demand**

What does it mean to be a price taker?



Households

- Each firm has an upward sloping supply curve, but:
    - price is determined by market supply and demand
    - so shifts of one household's demand curve do not affect the market price
- Each household faces infinitely elastic (horizontal) supply

Firms

- Each household has a downward sloping demand curve, but:
    - price is determined by market supply and demand
    - so shifts of one firms's supply curve do not affect the market price
- Each firm faces infinitely elastic (horizontal) demand

Firms' Basic Decisions

1. How much of each input to demand
2. Which production technology to use
3. How much supply

Short-Run vs. Long-Run

In the <u>short-run</u>, two conditions hold:

1. **firm is operating under a fixed scale of production – i.e. at least one input is held fixed** (ex. it may be optimal for a firm to buy new machinery, but it can't do so overnight)
2. **firms can neither enter nor exit an industry**

In the <u>long-run</u>:

- **there are no fixed factors of production, so firms can freely increase or decrease scale operation**
- **new firms can enter and existing firms can exit the industry**

Profit-Maximization

(economic) **profit = total revenue – total** (economic) **cost**

total revenue – amount received from the sale of the product (price times number of goods sold)

total (economic) **cost – the total of:**

1. **out of pocket costs** (ex. prices paid to each input)
2. **opportunity costs:**
   a. **normal rate of return on capital and**
   b. **opportunity cost of each factor of production** – ex. if an employee in my firm could earn $30,000 if he/she worked for another firm, then I'd have to pay him/her at least $30,000, otherwise he/she would leave. (In reality, you might work in your parents' firm and not be paid. In such a case, the accounting profit of their firm would be higher than the economic profit of their firm).

normal rate of return on capital – rate of return that is just sufficient to keep owners and investors satisfied (ex. stock dividends or interest on bonds)

- **nearly the same as the interest rate on risk-free government bonds for relatively risk-free firms**
- **higher for relatively more risky firms**

Production Process

optimal method of production minimizes cost

production technology – relationship betw/n inputs & outputs

- **labor-intensive technology relies heavily on labor instead of capital**
- **capital-intensive technology relies heavily on capital instead of labor**

production function – units of total product as func. of units of inputs

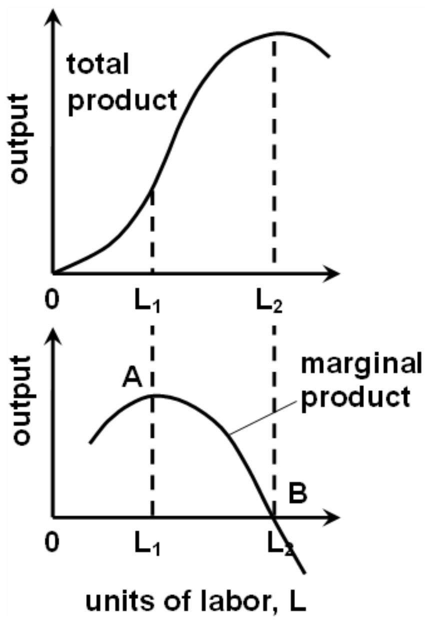
average product – average amount produced by each unit of a variable factor of production (input)

$$\text{avg. product of labor} = \frac{\text{total product}}{\text{total units of labor used}}$$

marginal product – additional output produced by adding one more unit of a variable factor of production (input), ceteris paribus

$$\text{marg. product of labor} = \frac{\Delta\ \text{total product}}{\Delta\ \text{units of labor used}}$$

Total, Average and Marginal Product



diminishing marginal returns – **when additional units of a variable input are added to fixed inputs, the marginal product of the variable input declines** (in the graph, diminishing marginal returns set in after point A)

marginal product is the slope of the total product function

point A – **slope of the total product function is highest; thus, marginal product is highest**

point B – **total product is maximum, the slope of the total product function is zero, and marginal product is zero**

Production with Two Inputs

Inputs often work together and are complementary.

- **Ex. cooks** (Labor) **and grills** (Kapital)
- **If you hire more cooks, but don't add any more grills, the marginal product of labor falls** (too many cooks in the kitchen)
- **If you hire (rent) more grills, but don't add any more cooks, the marginal product of capital falls** (grills sit idle)**.**

Given the technologies available, a profit-maximizing firm:

- **hires labor up to the point where the wage equals the price times the marginal product of labor (MPL)**
- **hires kapital up to the point where the rental rate on kapital equals the price times the marginal product of kapital (MPK)**

$$\text{Profits } (\Pi) = \text{Total Revenue} - \text{Total Cost}$$

$$\Pi = p_X X(K,L) - wL - rK$$

at profit maximum:

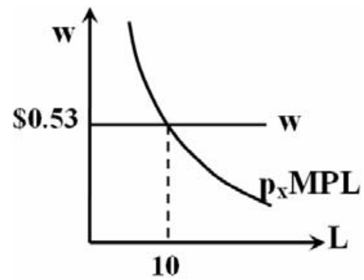
$$w = p_X MPL$$

$$r = p_X MPK$$

Profit Maximization with Two Inputs

- **In a perfectly competitive industry:**
  - **firms are price takers in both input output markets,**
  - **firms cannot affect the price of their product, nor can they affect the price of inputs** (wages, rental rate on kapital)**.**
- **Assume that a firm produces X with kapital and labor and that its production function is given by:**

$$X = K^{2/3} * L^{1/3}$$



- **Assume also that:**
  - **price of the firm's output is $1**
  - **wage rate and rental rate are both $0.53**
- **So its profits are given by:**

$$\Pi = p_x X - r*K - w*L$$
$$= \$1 * K^{2/3} * L^{1/3} - \$0.53*K - \$0.53*L$$

- **and firm should hire labor until** $w = p_X MPL$

Profit Maximization with Two Inputs

- **If the firm has 20 units of kapital on hand** (this is the short-run)**:**
  - **how much labor should it hire?**
  - **how much should it produce?**
  - **how much profit will it make?**

Output of X	Kapital	Labor	MPL
14.74	20	8	0.61
15.33	20	9	0.57
15.87	**20**	**10**	**0.53**
16.39	20	11	0.50
16.87	20	12	0.47

- **In the case depicted, the firm:**
  - **would hire 10 labor units**
  - **would produce 15.87 units of X**
  - **would make zero profit** … (I'm foreshadowing Lecture 8 a little here)

$$\Pi^* = \$1*\mathbf{15.87} - \$0.53*20 - \$0.53*\mathbf{10} = \$0$$

- **Hiring more labor or less labor would lower profit:**

$$\Pi_8 = \$1*\mathbf{14.74} - \$0.53*20 - \$0.53*\mathbf{8} = -\$0.14$$
$$\Pi_9 = \$1*\mathbf{15.33} - \$0.53*20 - \$0.53*\mathbf{9} = -\$0.07$$

$$\Pi_{11} = \$1*\mathbf{16.39} - \$0.53*20 - \$0.53*\mathbf{11} = -\$0.03$$
$$\Pi_{12} = \$1*\mathbf{16.87} - \$0.53*20 - \$0.53*\mathbf{12} = -\$0.06$$

isoquants

Recall the production function I used above:

$$X = K^{2/3} * L^{1/3}$$

and solve for K:

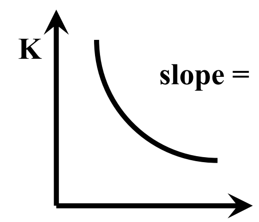
$$K = X^{3/2} * L^{-1/2}$$

This second equation shows us how much we need to increase use of kapital as labor inputs decrease in order to hold output constant.

This relationship gives us an "isoquant."

isoquant – shows all combinations of kapital and labor that can be used to produce a given level of output.

Kapital	Output of X	Labor	slope
22.36	15.87	8	-1.40
21.08	15.87	9	-1.17
20.00	**15.87**	**10**	**-1.00**
19.07	15.87	11	-0.87
18.26	15.87	12	-0.76



$$\text{slope} = \frac{\Delta K}{\Delta L} = -\frac{MPL}{MPK}$$

Slope of isoquant: marginal rate of technical substitution

isocosts

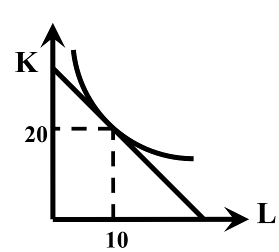
- Recall that the wage rate and the rental rate were both equal to $0.53
- So what's the relative wage?
- You can trade one unit of labor for one unit of capital at a one-to-one ratio, so the relative wage is:

$$\frac{w}{r} = \frac{\$0.53/\text{unit of labor}}{\$0.53/\text{unit of kapital}} = 1\,\frac{\text{unit of kapital}}{\text{unit of labor}}$$

- The relative wage gives us the slope of the isocost line.

Isocost line – shows all possible quantities of labor and kapital which yield the same total cost.

The optimal employment levels of kapital and labor are given by at the point where the isoquant is tangent to (just touches) **the isoquant.**



Note that the isocost line looks just like a budget constraint.
Note that the isoquant curve looks just like an indifference curve.

Application to Land Value Taxation

As you'll read in my memo ("economic thought on Land Value Taxation")**, I was asked for my opinion on how shifting a city's property tax burden from the combined value of the land and building, to the value land primarily would affect investment in the city's existing stock of buildings.**

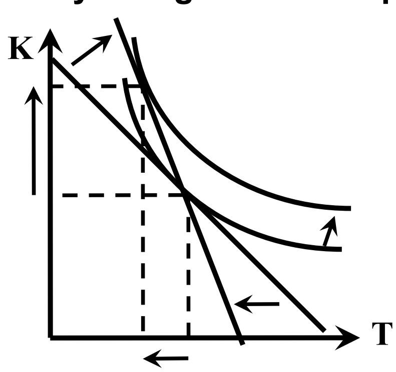
If you think of kapital (buildings) and land (abbreviated T for "Terra") as inputs into the **production of asset returns** and if you think of tax rates as the input prices, then you can analyze the question with isoquants and isocosts.

They had hoped that by taking the tax burden off of the building's rental value, property owners would have a greater incentive to renovate their properties – renovation is a form of investing in capital**.** (They were seeking to rid the city of unsightly abandoned properties)**.**

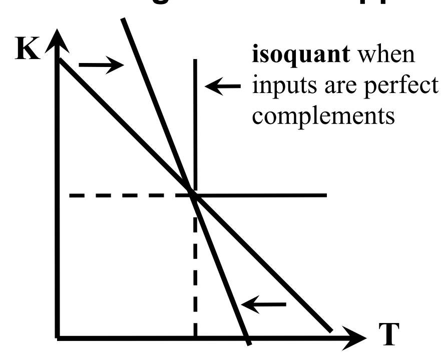
The **effective price of an asset** equals $\frac{p_{asset}}{1-\tau}$, where p_{asset} is the market price of the asset and τ is tax on the return to the asset.

Land Value Taxation

what they thought would happen:



what I thought would happen:



Under the proposal, the overall tax burden would remain constant, so the only effect would be a substitution effect. If the isoquants have a nice curved shape, then property owners would substitute out of land and into kapital and their asset returns would be higher.

I argued that the isoquants may be L-shaped due to the complementarity between land and buildings. Consequently, the proposal would have no effect on the optimal holdings of land and kapital.