The Costs of Production

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Industrial Organization

- **Industrial Organization:** The study of how firms' decisions about prices and quantities depend on the market conditions they face.
- We assume that the goal of a firm is to maximize profit. Firms earn revenue from the sale of their output: $TR = PQ$
- Moreover, firms also incurs some costs to produce. The market value of the inputs a firm uses in production are the firm's total costs.
- Profit (Π) is given by $\Pi = TR - TC$.

Opportunity Costs

- When we talk about a firm's costs of production, we will include *all* the opportunity costs of making its output.
- The firm's opportunity costs are divided into two pieces:
  1. Explicit costs: Input costs that require an outlay of money by the firm.
  2. Implicit costs: Input costs that do not require an outlay of money.

Economic vs Accounting Profit

- Why do we include implicit costs? They affect firm decisions – opportunity costs should be taken into account.
- **Economic profit:** *TR* - (explicit costs + implicit costs).
- **Accounting profit:** *TR* - explicit costs.
- Since economic profit includes implicit costs, it will generally be lower than accounting profit.

Production Functions

- **Production Function:** Relationship between quantity of inputs used to make a good and the quantity of output.

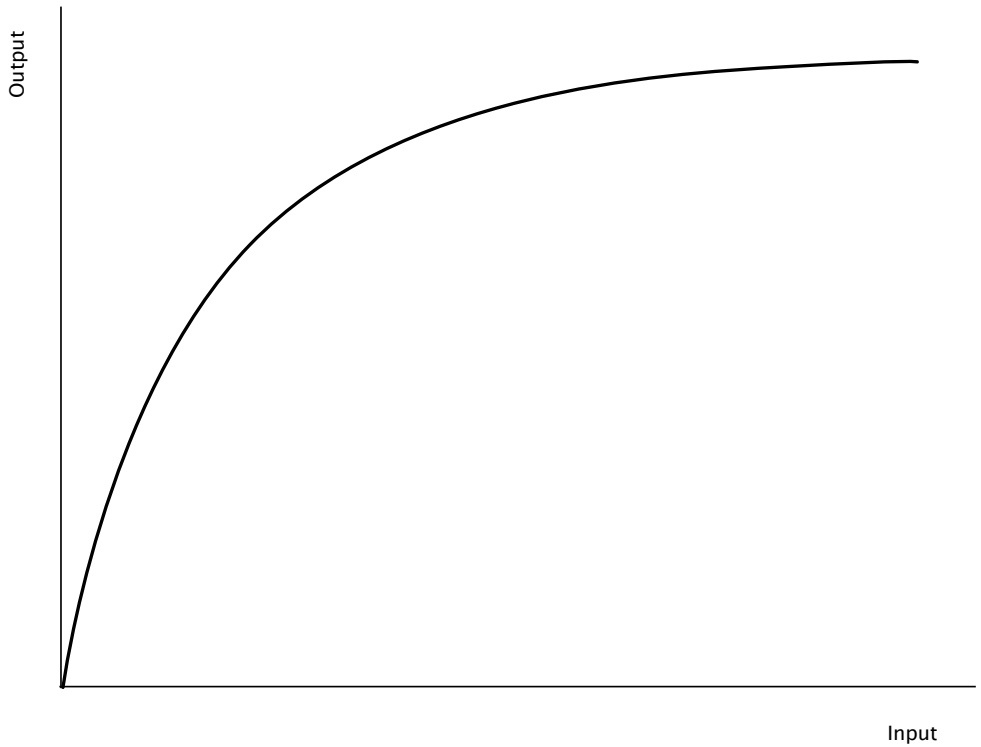

Figure: Simplified Production Function

Production Functions

- Rational people (and firms) think on the margin.
- With this in mind, the **marginal product** of an input is the increase in output from an additional unit of input.
- Notable marginal products:
  - $MP_L = \frac{\Delta Q}{\Delta L}$
  - $MP_K = \frac{\Delta Q}{\Delta K}$

Production Functions

Example

Consider Table 1 below. What is the marginal product of labor of the second worker? The fifth? Draw a graph and show the MP_L at each unit of labor.

Table: Production of Frozen Bananas

Number of workers	*Output (per day)*	*MPL*
0	*0*	*—*
1	*20*	*20*
2	*35*	*15*
3	*45*	*10*
4	*50*	*5*
5	*52*	*2*
6	*53*	*1*

Production Functions

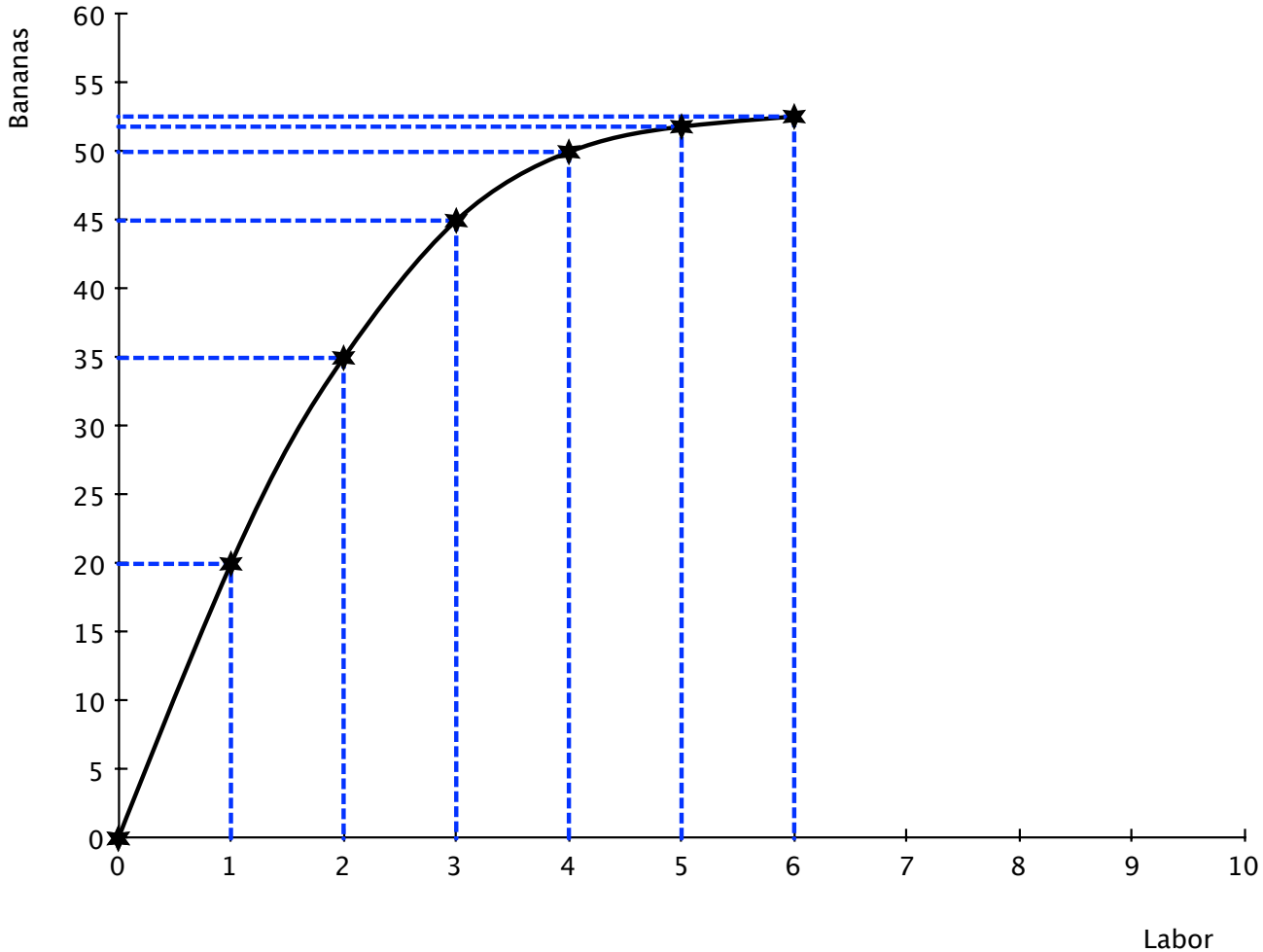

Figure: Marginal Product of Labor

Production Functions

- Properties of the Production Function:
  1. An increase in inputs increases output.
     - $MP_L > 0$, $MP_K > 0$
  2. Diminishing marginal product: MP declines (eventually) as the number of inputs increases.

The Costs of Production

- Because of diminishing marginal product, the cost curve becomes steeper as the quantity of output increases.
  - As Q increases, producing an additional unit of output requires a lot of additional units of inputs and so is more costly.

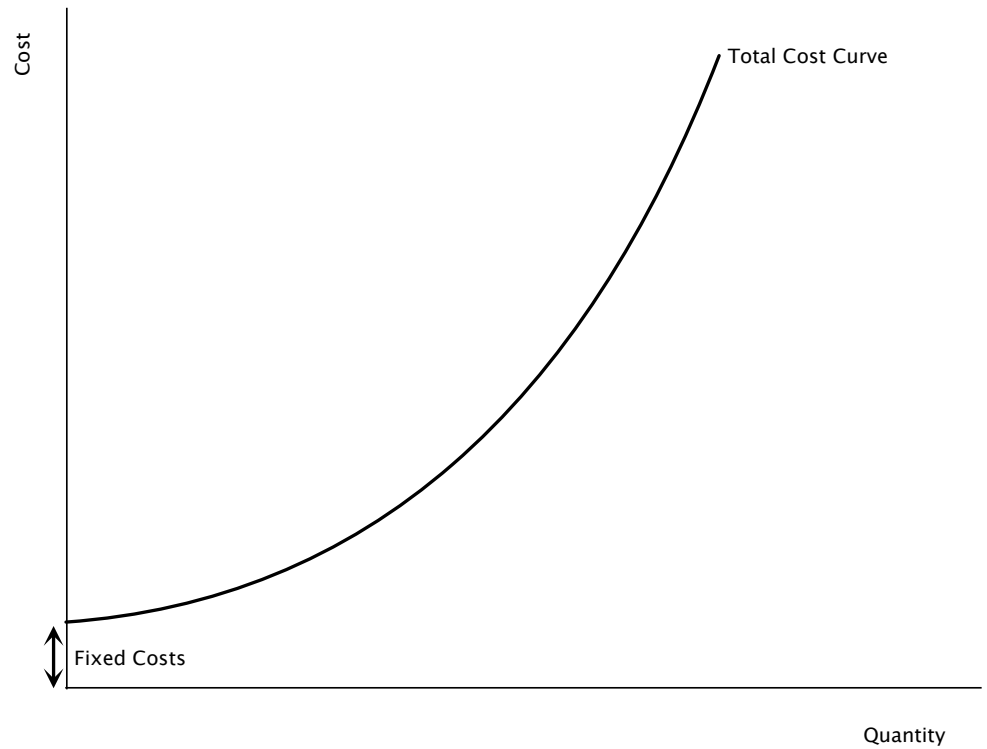

Figure: Simplified Total Cost Curve

The Costs of Production

- **Fixed Costs (FC):** Costs that do not vary with the quantity of output produced.
- **Variable Costs (VC):** Costs that vary with the quantity of output produced.
- If a producer does not produce any output his variable costs are zero.
- **Total costs (TC):** $FC + VC$.

The Costs of Production

- **Average Total Cost:** The cost of making a typical unit of output.

$$ATC = TC/Q$$

- **Average Fixed Cost:** $= FC/Q$
- **Average Variable Cost:** $= VC/Q$

$$ATC = \frac{FC + VC}{Q} = FC/Q + VC/Q = AFC + AVC$$

The Costs of Production

- **Marginal Cost:** The increase in total costs that arises from producing an extra unit of output.

$$MC = \frac{\Delta TC}{\Delta Q} = \frac{\Delta VC}{\Delta Q}$$

- **Efficient scale:** The quantity of output that minimizes ATC.

The Costs of Production

Example

Julien also owns a juice bar, which has the following cost schedule:

Table: Production of Mango Juice

Quantity	*Variable Cost*	*Total Cost*	*AVC*	*ATC*	*MC*
0	*$0*	*$30*	—	—	—
1	*$10*	*$40*	*10*	*40*	*10*
2	*$25*	*$55*	*12.5*	*27.5*	*15*
3	*$45*	*$75*	*15*	*25*	*20*
4	*$70*	*$100*	*17.5*	*25*	*25*
5	*$100*	*$130*	*20*	*26*	*30*
6	*$135*	*$165*	*22.5*	*27.5*	*35*

Calculate the AVC, ATC, and MC for each quantity.

The Costs of Production

Example

Julien's Frozen Banana stand has the following ATC schedule:

Table: ATC of Frozen Bananas

Quantity	*Average Total Cost*
600	*$3.00*
601	*$3.01*

He made 600 bananas today and sold them all. He is about to close up shop when someone calls, desperate to escape the heat and buy a banana. She offers to pay $5.50 for it. Should Julien accept this offer or not? Why?

The Costs of Production

Example

Julien's Frozen Banana stand has the following ATC schedule:

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$MB = MR = \$5.50$. $MC = 9.01$. Nope, don't sell since $MC > MB$.

The Costs of Production - Properties

1. Marginal cost: Rising marginal costs (reflects diminishing MP).
2. Average fixed cost: Always decreasing since FC are constant.
3. Average variable cost: Rising due to diminishing MP.
4. Average total cost:
   - U-shaped due to addition of AFC & AVC.
   - At low Q, high AFC, low AVC leads to high ATC.
   - As Q increases, AFC decreases fast initially while AVC increases at constant rate so ATC decreases.
   - At high Q, AFC decreases slowly and increasing AVC becomes dominant effect so ATC rises.

The Costs of Production - Properties

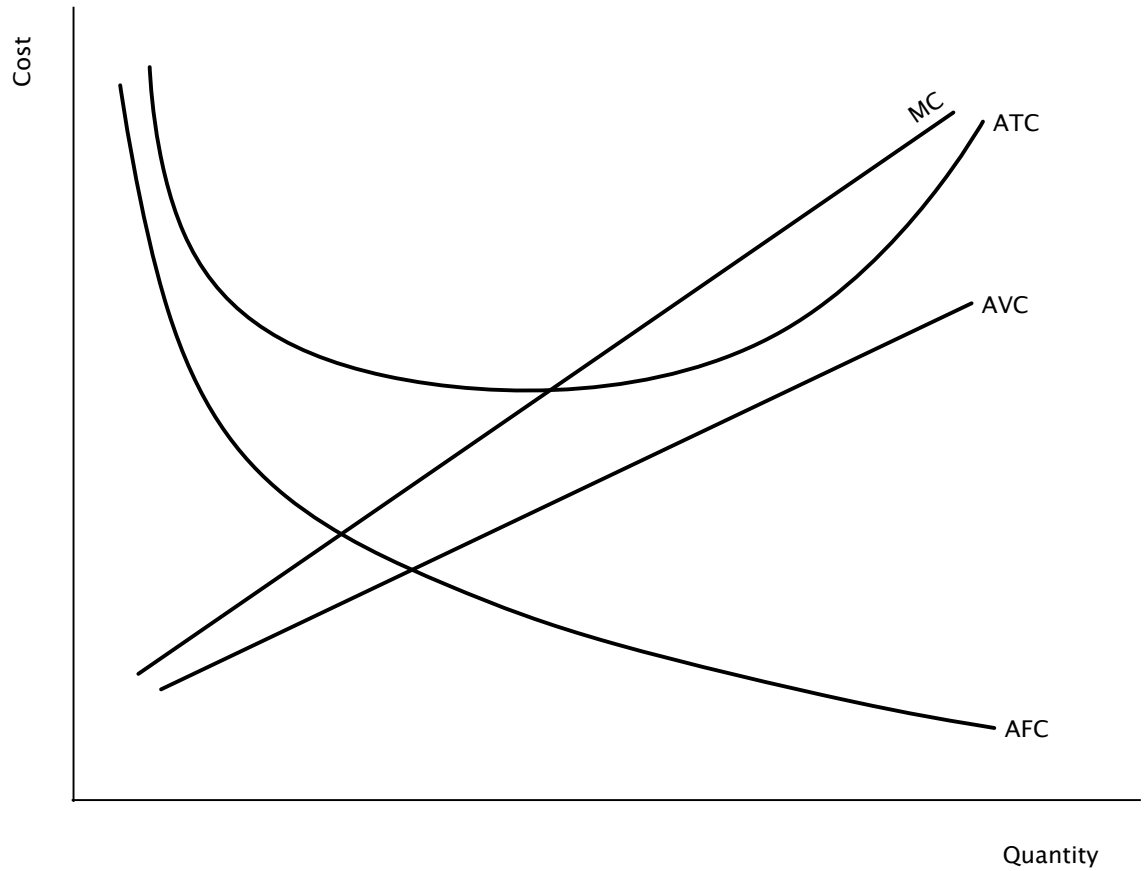

Figure: Simplified Cost Curves

The Costs of Production

- If we are at a level of production where marginal costs are less than average total costs, then average total costs are decreasing.
- If we are at a level of production where marginal costs are greater than average total costs, then average total costs are increasing.

The Costs of Production - Properties

- If the next unit of input adds less to production costs than current average, average cost will decrease.
- If the next unit of input adds more to production costs than the current average, average cost will increase.
- As a result, ATC and MC meet at the minimum of ATC.

The Costs of Production - Properties

- We made the simplifying assumption that firms exhibit decreasing marginal product for all levels of inputs in order to get the main points associated with production and costs across.
- However, this is not generally the case.
- Generally, MP increases initially before decreasing after some level of inputs.

The Costs of Production - Properties

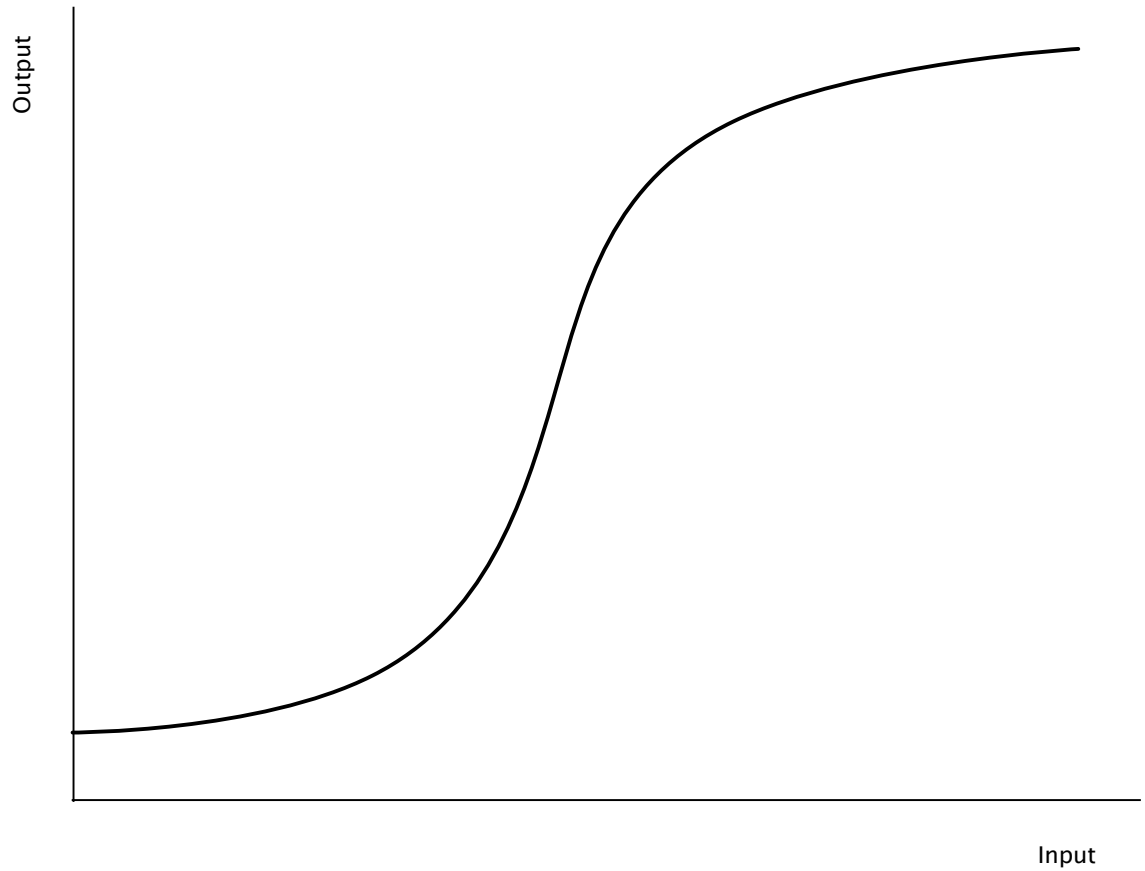

Figure: Standard Production Function

The Costs of Production - Properties

1. MC still increases after some Q.
2. ATC still u-shaped.
3. MC crosses ATC and AVC at their minimum.

The Costs of Production - The Long Run

- In the short run, a firm cannot get rid of its fixed costs because they are sunk. However, in the long run, these costs become variable.

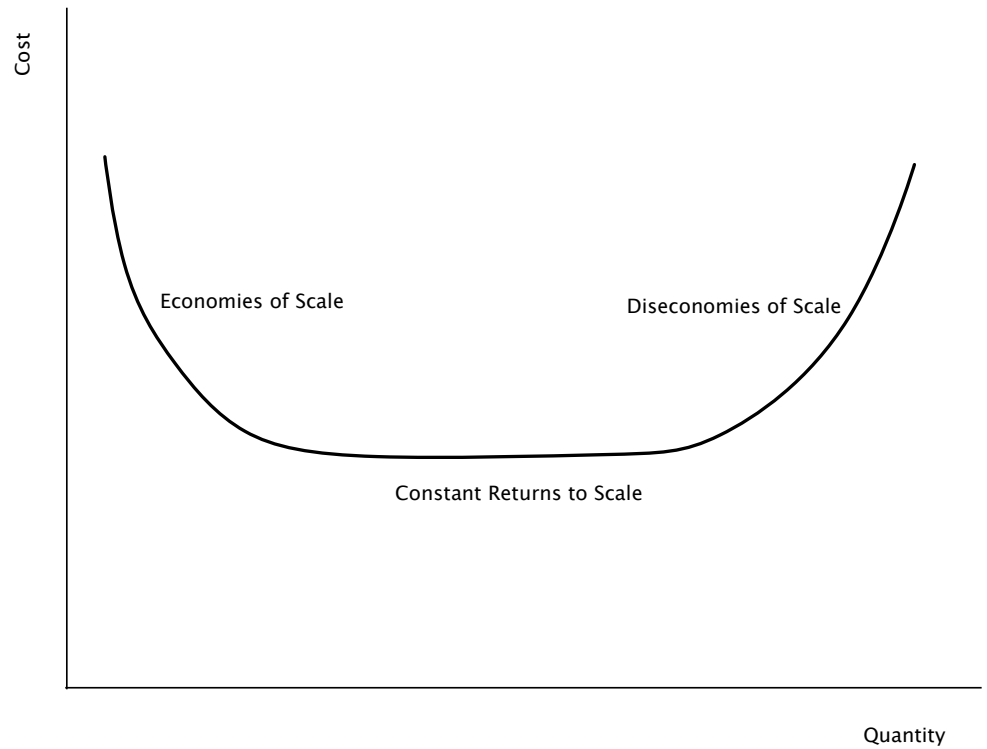

Figure: Long-Run ATC

The Costs of Production - The Long Run

- **Economies of Scale:** Property whereby long-run ATC decreases as Q increases.
- **Constant Returns to Scale:** Property whereby long-run ATC remains constant as Q increases.
- **Diseconomies of Scale:** Property whereby long-run ATC decreases as Q increases.

Readings and Assignments

- Today: Mankiw Ch. 13
- Next time: Mankiw Ch. 14
- Problem Set 3, section 1