Chapter 11

The Production Function

- **Production Function** – the relationship between the quantity of inputs a firm uses and the quantity of output it produces
- Production is the process of turning inputs into outputs
- The cost structure of a firm depends on the nature of the production process
- Inputs and Output
    - **Fixed input** – an input whose quantity is fixed for a period of time and cannot be varied
    - **Variable input** – an input whose quantity can be changed by the firm at any time
    - **The long run** – the time period in which all inputs can be varied
    - **The short run** – the time period in which at least one input is fixed
    - **Total product curve** – shows how the quantity of output depends on the quantity of the variable input, for a given quantity of the fixed input
        - Fixed inputs cannot be changed in the short run, so any changes in quantity are a result of the variable inputs
    - **Marginal product** of an input is the additional quantity of output that is produced by using one more unit of that input
        - *Marginal product of labor* is the change in output resulting from one-unit increase in the amount of labor input
            - MPL = change in quantity of output / change in quantity of labor
            - MPL = ΔQ / ΔL
            - Because slope is rise/run, and in the graph of total product curve, y=quantity=rise, and x=labor=run, the marginal product of labor is equal to the total product curve (slope is rise/run = quantity/labor, and marginal product of labor is quantity/labor)
        - Marginal product initially rises as more workers are hired (this is because of specialization)
        - Then, it declines: **diminishing marginal product** (aka diminishing returns to an input) – an increase in the quantity of that input, holding the levels of all other inputs equal, leads to a decline in the marginal product of that input
- Total product, marginal product, and fixed input
    - With more land (changing the fixed input), each worker can produce more (the total product curve shifts upwards)
    - Additionally, the MPL is higher with a higher fixed input (the MPL curve shifts up)
- From the Production Function to Cost Curves
    - A **fixed cost** is a cost that does not depend on the quantity of output produced (short run). It is the cost of the fixed input.

- A **variable cost** is a cost that depends on the quantity of output produced (short run). It is the cost of the variable input.
- The **total cost** of producing a given quantity of output is the sum of the fixed cost and the variable cost of producing that quantity of output
    - TC = FC + VC
    - **Total cost curve** shows how total cost depends on the quantity of output
    - The total cost curve becomes *steeper* as more output is produced, a result of diminishing returns
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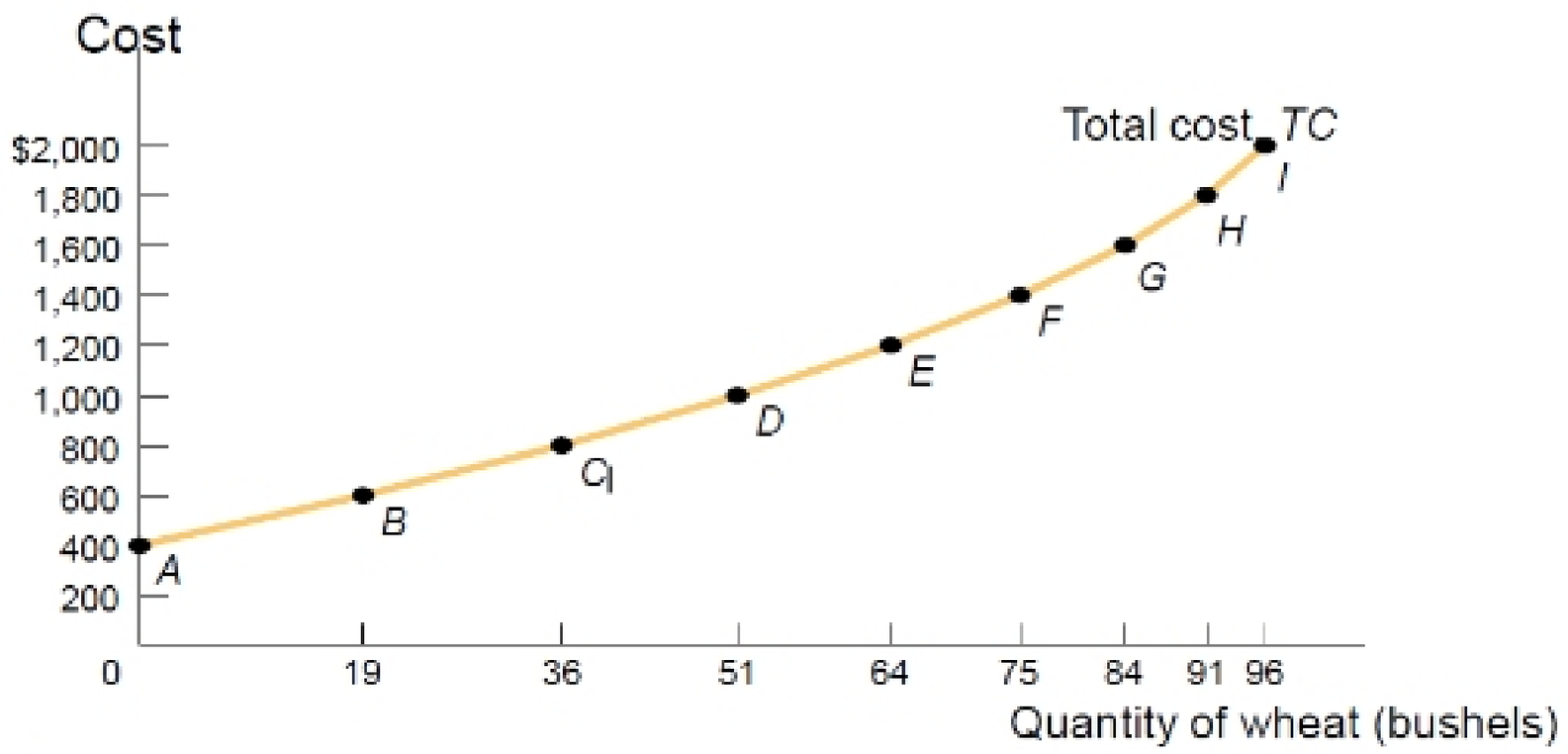

Point on graph	Quantity of labor (worker)	Quantity of wheat (bushels)	Variable cost (*VC*)	Fixed Cost (*FC*)	Total cost (*TC* = *FC* + *VC*)
A	0	0	$0	$400	**$400**
B	1	19	200	400	**600**
C	2	36	400	400	**800**
D	3	51	600	400	**1,000**
E	4	64	800	400	**1,200**
F	5	75	1,000	400	**1,400**
G	6	84	1,200	400	**1,600**
H	7	91	1,400	400	**1,800**
I	8	96	1,600	400	**2,000**

    - As shown, *even when there is no output, the producer still has to pay the fixed cost*, because that cost is there regardless of any changes in output

Marginal Cost and Average Cost

- **Marginal cost** – the change in total cost generated by one additional unit of output
    - MC = (change in total cost) / (change in quantity of output) = ΔTC / ΔQ
    - As in the case of marginal product, marginal cost is equal to the increase in total cost divided by the increase in the quantity of output
    - Marginal cost is equal to the slope of the total cost curve (same logic as above)

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Quantity of salsa *Q* (cases)	Fixed cost *FC*	Variable cost *VC*	Total cost *TC = FC + VC*	Marginal cost of case *MC = ΔTC/ΔQ*
0	$108	$0	$108	
				$12
1	108	12	120	
				36
2	108	48	156	
				60
3	108	108	216	
				84
4	108	192	300	
				108
5	108	300	408	
				132
6	108	432	540	
				156
7	108	588	696	
				180
8	108	768	876	
				204
9	108	972	1,080	
				228
10	108	1,200	1,308	

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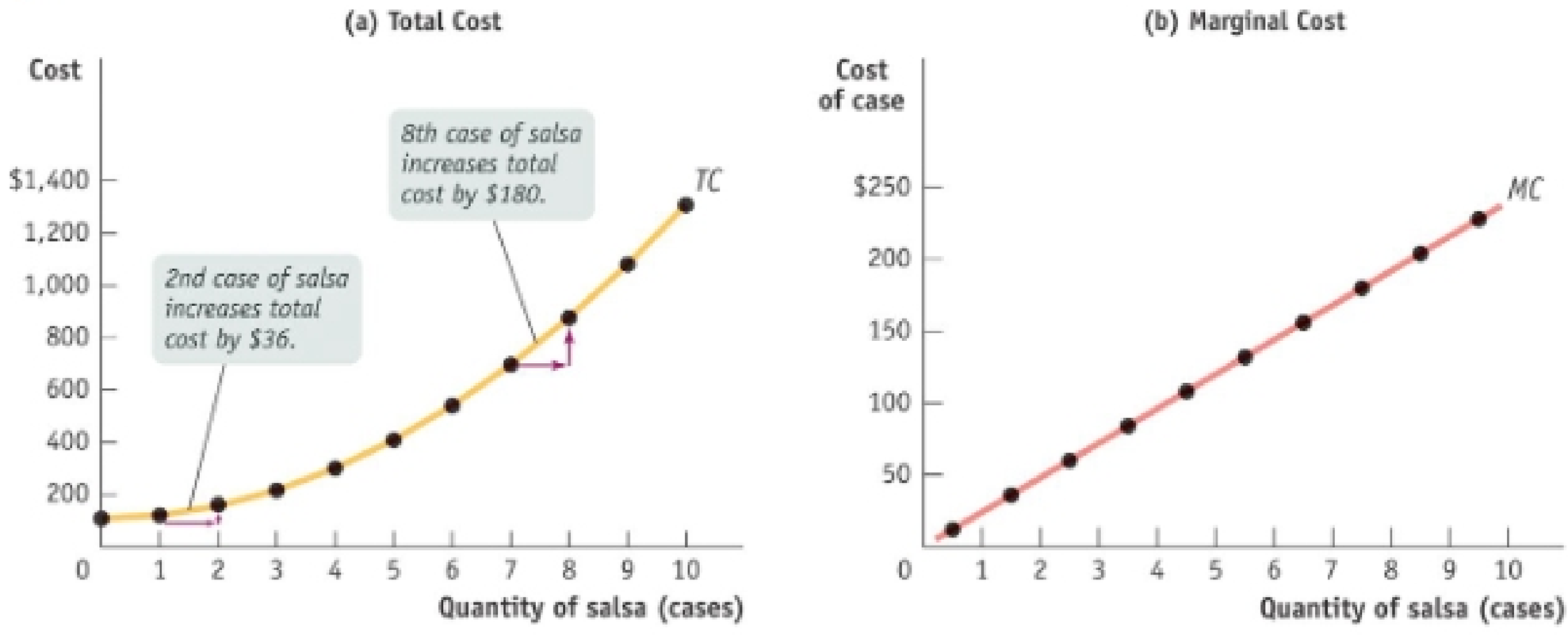

- Why is the marginal cost curve upward sloping?
  - Diminishing returns to inputs (as output increases, the marginal product of the variable input declines)