Production and Costs

The Micro Model of Producer Behavior

Profits and Revenue

Firms **exist** to **enrich their owners** through **commercial activity**. They enrich their owners, generally, when they make **profits**.

$$Profits = Revenue - Cost$$

Revenue is the easy part. Revenue is money earned by firms. If a firm sells output (Q) at a price (P), then total revenue is $P \times Q$.

$$TR = P \times Q$$

Costs

Costs are a little harder to figure. Let's consider two forms:

Explicit costs – expenses paid by a firm to *acquire* ownership of resources; "Do you have a receipt/invoice?"

Implicit costs – counterfactual opportunity costs 'paid' by firms to *use* a resource they already own; "Are you still using that?"

Accounting and Economic Profit

$$Accounting\ profit\ =\ Revenue - Explicit\ Costs$$

$$Economic\ profit\ =\ Revenue - (Explicit\ +\ Implicit\ Costs)$$

Firms could make a **positive accounting profit** ("We're in the black!") and still make a **significant economic loss**.

The Short Run and Long Run

In economics, the **short run** and **long run** are not defined in terms of time, even though they relate to different amounts of time. Instead, they refer to **flexibility**.

The **short run** is the period of time over which a firm has **little flexibility**; much of what it is doing is **fixed**.

The **long run**, in contrast, is the period over which a firm could change **nearly every single thing** about itself. Nothing is fixed.

Production and Profitability

Consumers are trying to find the **most satisfaction** (or utility) **given the constraints** they face. These **constraints** include the **amount of income** they have and the **prices they face**.

Firms, similarly, are trying to be **profitable** and they face **constraints**. The first major constraint is their **production technology**, or their ability **to turn inputs into outputs**. They then have to worry about **input prices** and **output prices**.

Production, Inputs and Output

We will start with a **model of production** in the **short run**.

For simplicity, we will assume that the firm uses only labor (L) and capital (K) to produce some output (Q). In this short run, the firm can **only adjust** the **amount of labor** it uses. When labor changes, output changes.

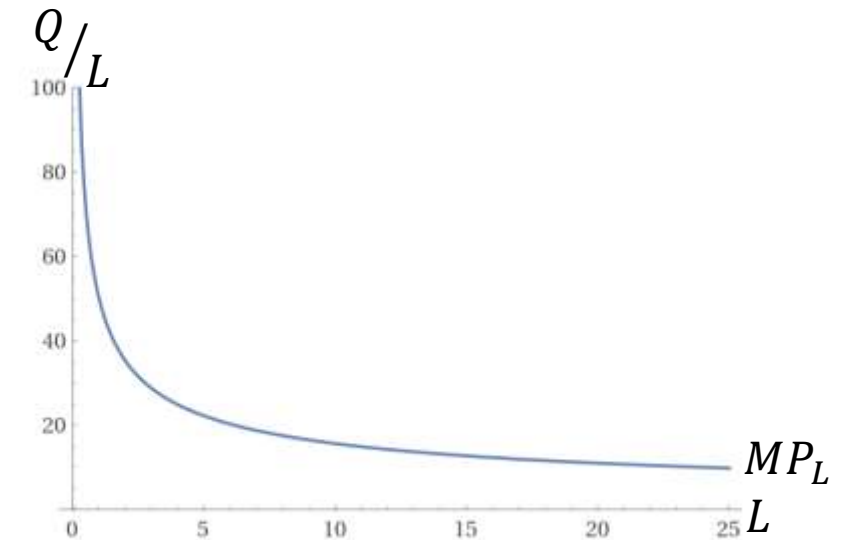Next we will look at **production technologies** or **functions**.

Total Product and Marginal Product

To the right I have a total product curve on the top graph with marginal product of labor (MP_L) on the lower graph.

The total product graph is increasing in labor (L) but at a decreasing rate, which is to say the marginal product of labor is diminishing.
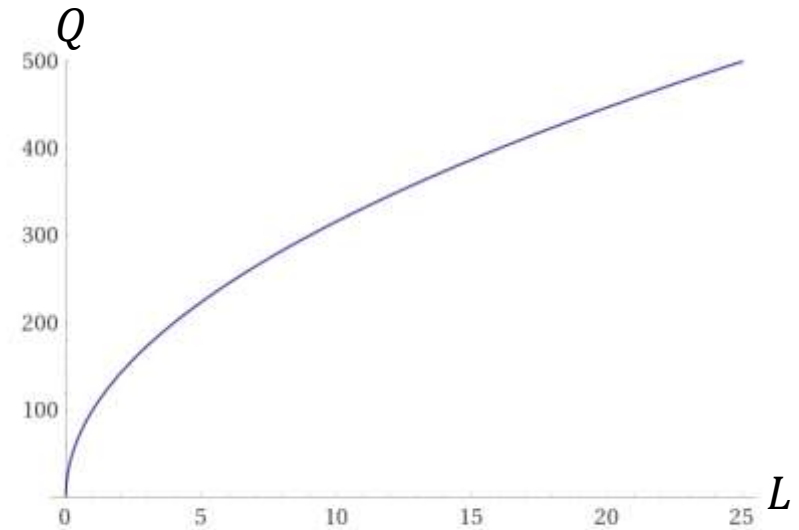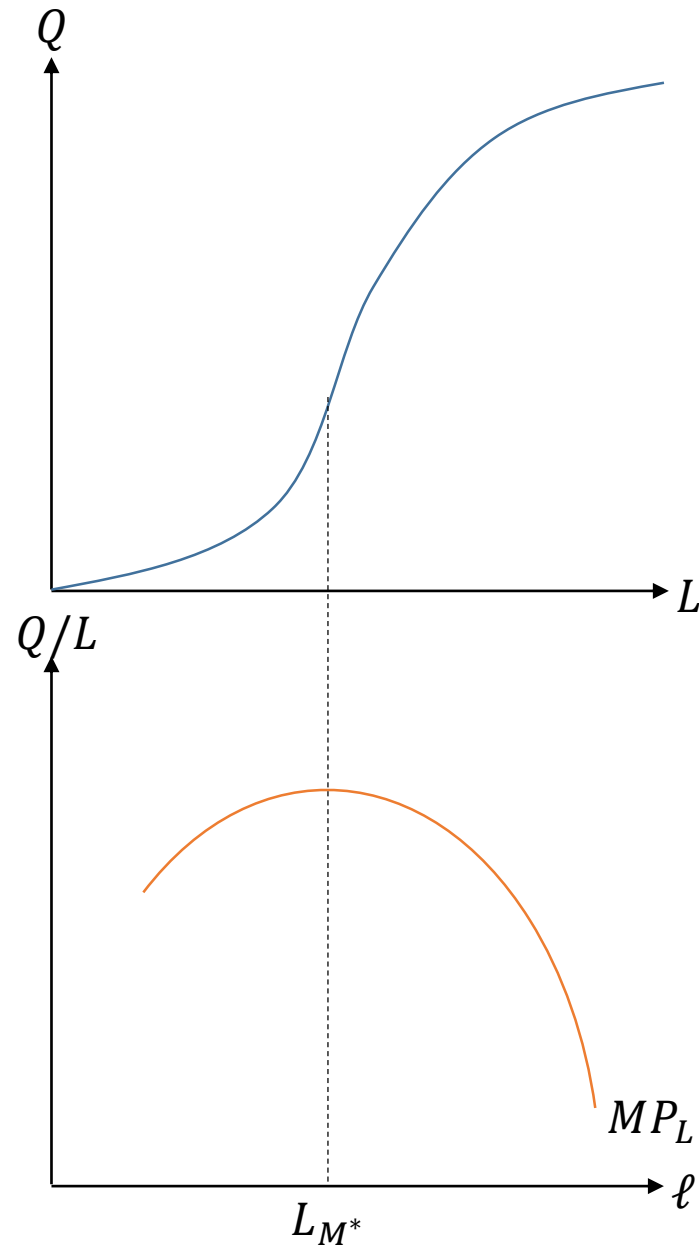
Total Product and Marginal Product

Here is a different total product function. Notice that the slope is increasing at a increasing rate, but then it begins diminishing (increasing at a decreasing rate). This means the marginal product curve is increasing at first and then decreasing.

Choosing Inputs Optimally

In a production process with only one input, the decision of optimal input is **comparatively easy**.

When there are **multiple variable inputs**, or in the case of **choosing to fix one or more input(s)** in a given short run, **managers** have to be careful that **the combination** of inputs is **optimal**, that is, **cost minimizing**.

Cost Minimization

"**Cost Minimization**" is sometimes a misleading term. It means **producing** any level of **output** in the **cheapest way possible**, **given** the **constraints** of **technology** and **input prices**.

The **rule of maximization** is that **bang-for-your-buck** must be **equal across all inputs**!

$$\frac{MP_L}{wage} = \frac{MP_K}{rental\ rate}$$

From Production to Costs

Product curves illustrate how a firm can turn **inputs into output**.

Next we will derive **cost curves**, which relate how costly (expensive) it is, in **total** and at the **margin**, to **produce output**.

First, we will explore some **vocabulary**.

Fixed and Variable Costs

Variable costs are those costs that depend on **how much output** is made. These costs are borne only in the case of producing output and increase with the use of **variable inputs**.

Fixed costs are borne whether any **output is made or not**, and **do not change as output changes**. They arise because of **fixed inputs**.

Costs will be either fixed or variable in the long or short run depending which inputs are fixed or variable.

Costs are in the Future, not in the Past

Whether we are talking about a short run (which is defined by a lack of flexibility in the choices available) or the long run (which is defined by ultimate flexibility), **costs are about choices** that managers make.

Costs lie **in the future**, insofar as **they reflect value** or options **foregone**. Fixed costs are distinct from **sunk costs**, which, truthfully, are **not costs** in the sense we're using the term.

Total Costs

We will begin with thinking about the costs a firm faces in producing output to sell on the market.

Total costs are the **sum** of all **fixed costs** and **variable costs**

$$TC = FC + VC$$

Marginal and Average Costs

Marginal costs are the **change in total costs for a change in output**.

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

Average total costs are **total costs** divided by **the amount of output**:

$$ATC = \frac{TC}{Q}$$

Total Costs and Marginal Costs

Total costs are the sum of fixed and variable costs,

$$TC = FC + VC$$

And since fixed costs (FC) do not change with output decisions, **marginal costs** will pertain only to the **change in variable costs** (VC) as output goes up or goes down.
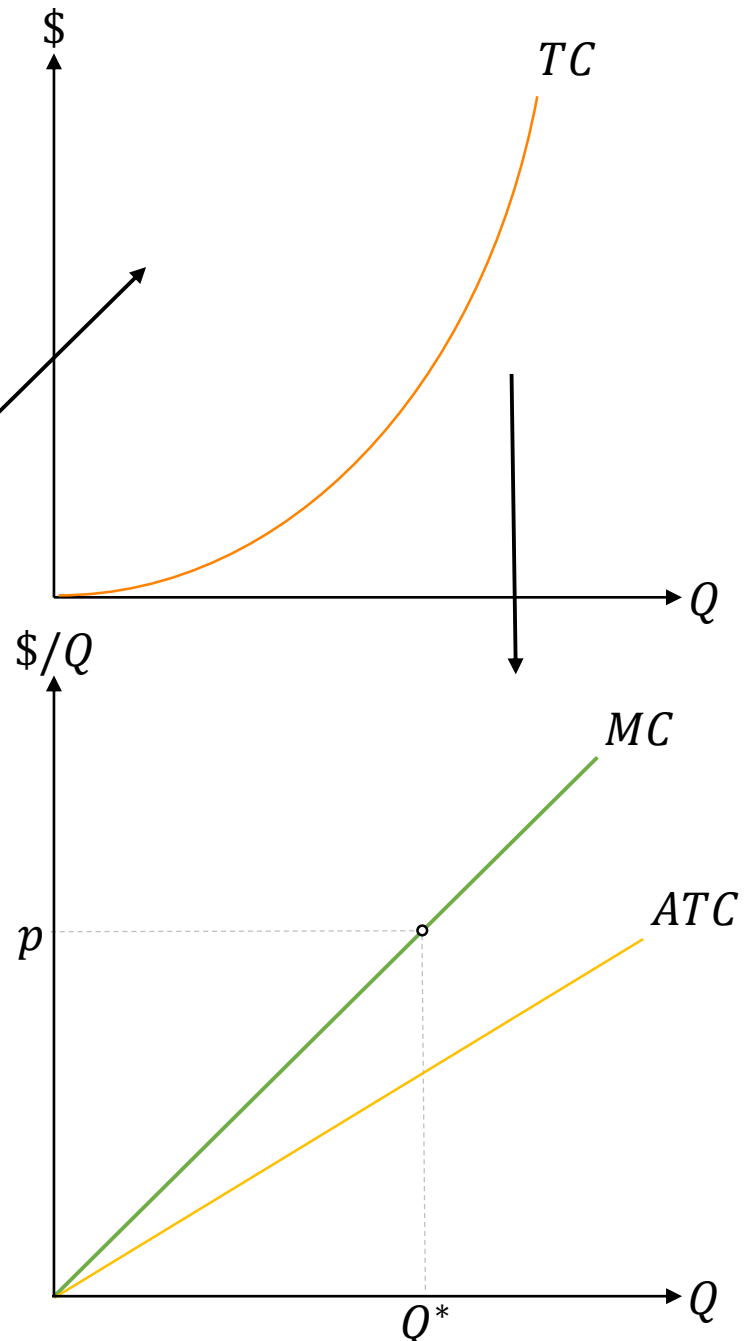
Cost Curves from Product Curves

If we have the **total product relationship**, the level of output arising from a level of input(s), then we can get the total cost curve in two steps:

1. **Invert** the relationship between outputs (vertical axis) and inputs (horizontal axis)

2. **Monetize the inputs**: for every unit of labor (L), multiply by wage (w); for every unit of capital (K), multiply by the rental price (r), etc.
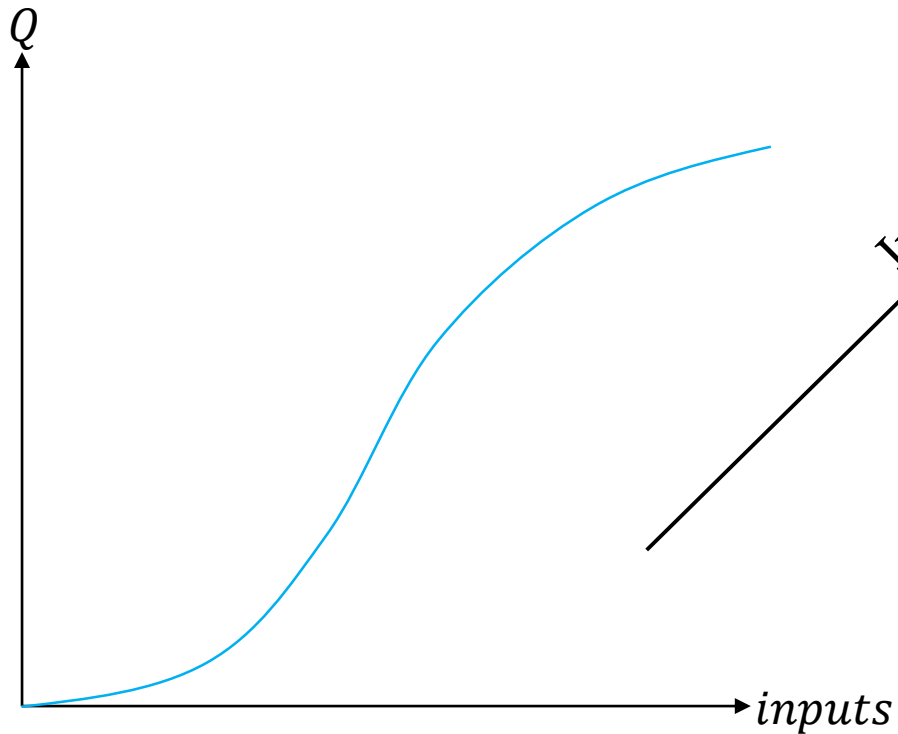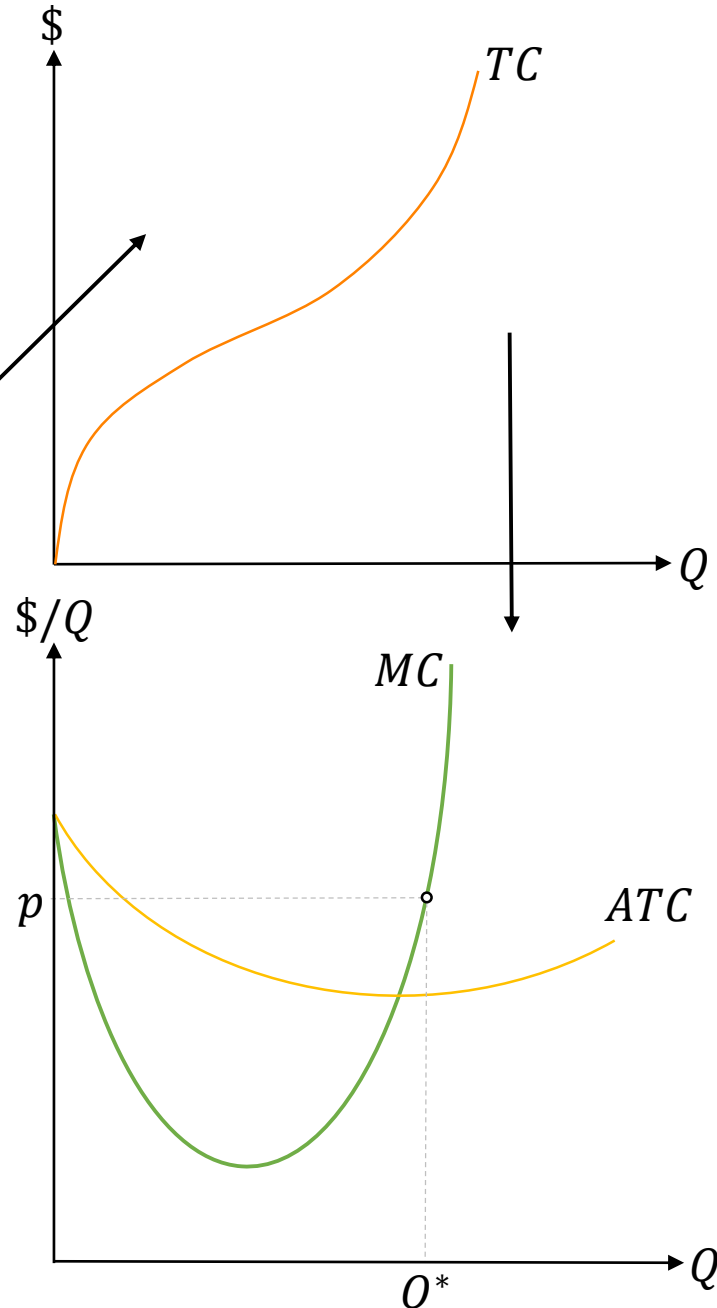
Deriving Cost Curves
Zero Fixed Costs
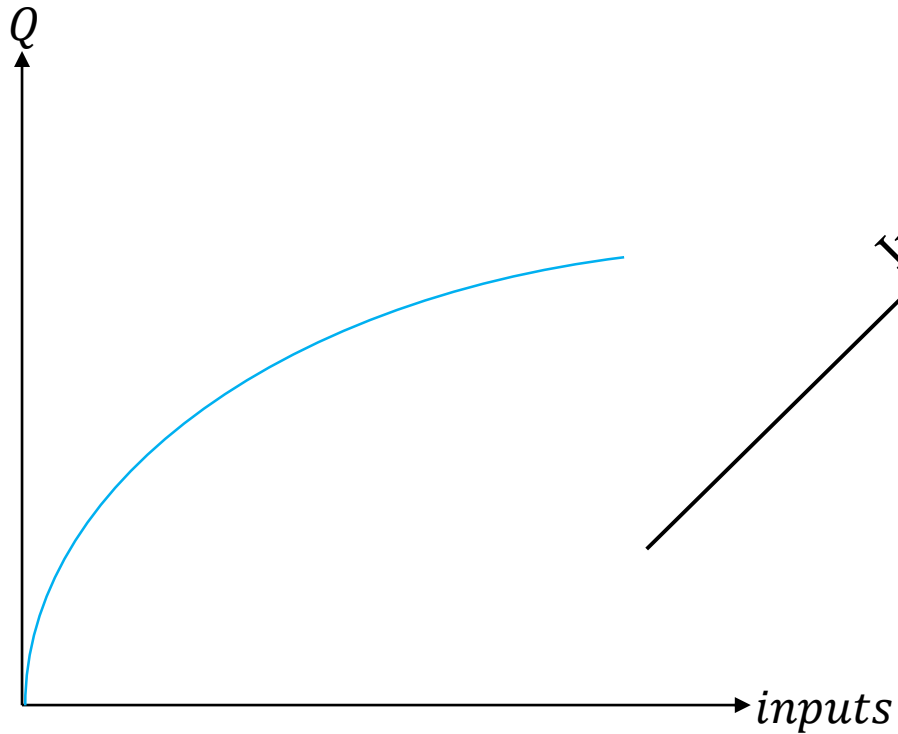
Deriving Cost Curves
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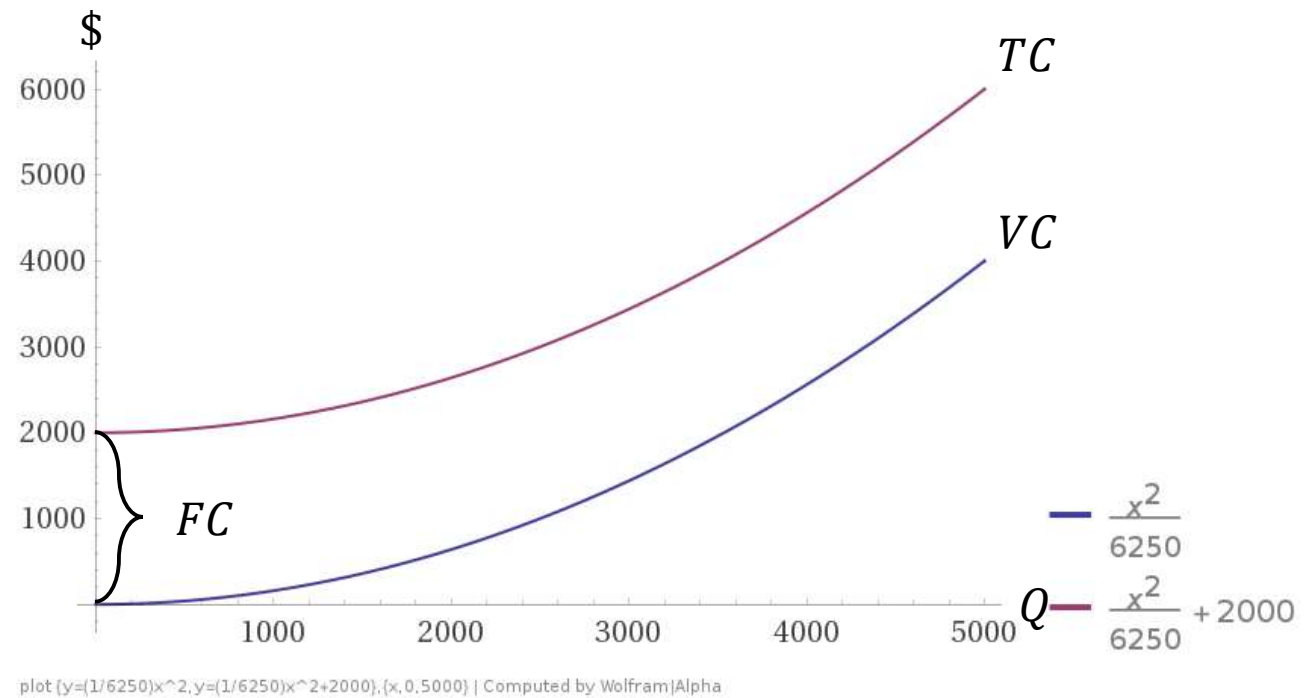
Short-Run Costs: An Example

Here we have a production process that gives us an upward-sloping total cost curve; **costs** are rising with **output at an increasing rate**.
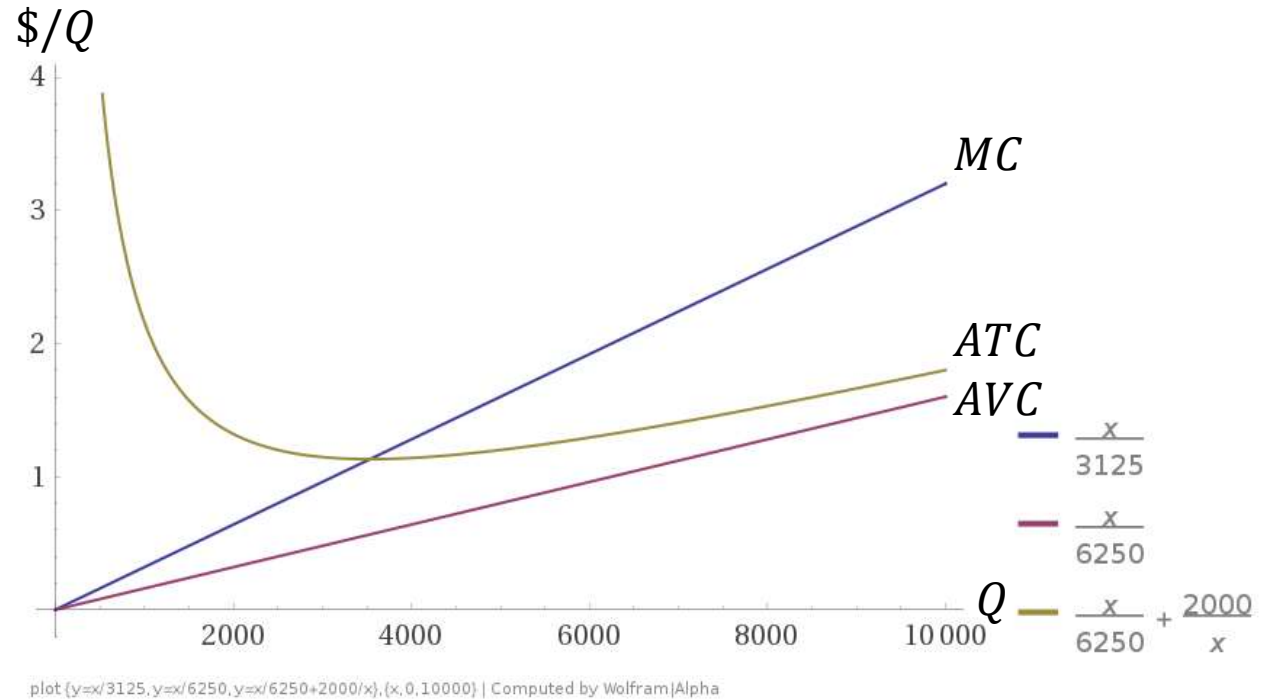
There is some fixed cost, $FC = 2000$, that raises TC over VC.

plot {y=(1/6250)x^2,y=(1/6250)x^2+2000},{x,0,5000} | Computed by Wolfram|Alpha

Short-Run Costs: An Example

From those **_TC_** and **_VC_** curves on the previous slide, we can derive three curves that interest us:

1. Short-run MC

2. Short-run ATC

3. Short-run AVC

$\$/Q$

MC

ATC

AVC

Q

$\dfrac{x}{3125}$

$\dfrac{x}{6250}$

$\dfrac{x}{6250} + \dfrac{2000}{x}$

plot {y=x/3125, y=x/6250, y=x/6250+2000/x}, {x, 0, 10000} | Computed by Wolfram|Alpha

Long-Run Costs

No firms exist or **operate** in the long run; it is a **state of potentiality** that defines what a firm **could be or could do**.

For this reason, **we do not care much about long-run marginal costs**, since marginal costs are about what to do in a particular context, and the long run is the envelope of possible contexts. We are generally **only interested in long-run average costs**.

Long-Run Average Costs

Most things that are **fixed inputs (costs) in short runs** are **variable inputs (costs) in the long run**.

There are **some long-run fixed costs** that can only be avoided by not existing as a firm; for instance, government license fees, entrepreneurial talent, or management skill.

These constitute long-run total costs and will be in long-run ATC.

Long-Run *ATC* is the Envelope of all Short-Run *ATC* Curves
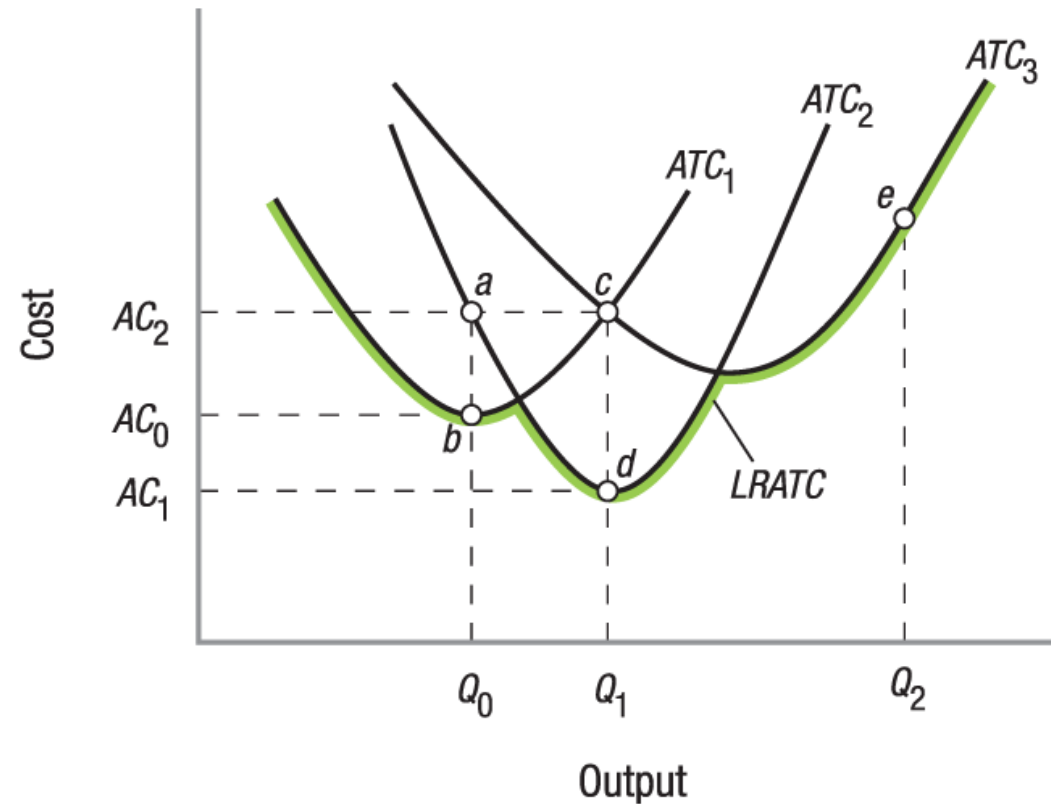
Chiang, *Microeconomics: Principles for a Changing World*, 5e © 2020 Worth Publishers

Cost Curves Managers Need to Make Wise Decisions

We have drawn a lot of curves, from product curves to cost curves in the long and short run. Each of these relationships can tell a manager something important about the production process, but there are a few that are especially important:

1. Short run MC – tells the firm **how much to produce** in the short run to maximize profit

2. Short run AVC – tells the firm **the minimum price** at which to **operate to have any hope of being profitable**

3. Long run ATC – tells the firm **the minimum price which to stay in the industry or to leave**
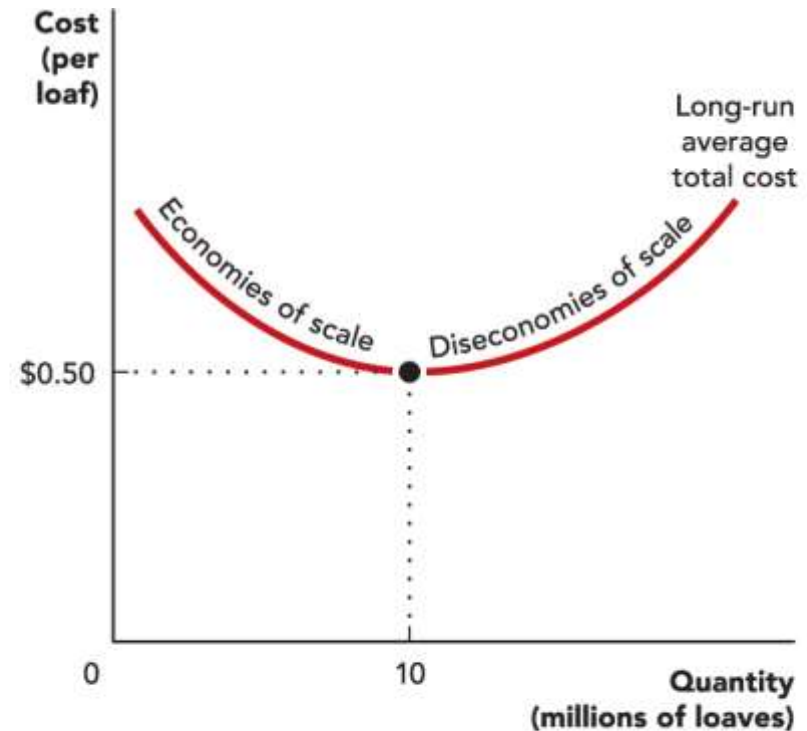
Economies and (Diseconomies) of Scale

The **shape of the long-run average total cost** *LRATC* tells firms **important information**.

When the *LRATC* is **downward-sloping** (economies of scale), the **average cost is falling** as output increases. When *LRATC* is flat, **the average cost is constant**. And when it is **upward-sloping** (diseconomies of scale), the **average cost is increasing** as output increases.

Economies of Scale

Firms have a strong incentive to keep **increasing production** when they are experiencing **economies of scale**? Why?

Competition tends to push firms into the **constant returns to scale range** of their $LRATC$. Firms experiencing **economies of scale increase output** while firms with **diseconomies of scale will decrease output**.

Cost (per loaf)

Long-run average total cost

Economies of scale

Diseconomies of scale

$0.50

0   10   Quantity (millions of loaves)

Anderson, *Survey of Economics*, © 2019 Worth Publishers