Draw a typical firm’s (short-run) marginal cost, average total cost, average variable cost and marginal revenue curves.

Explain why the curves have these shapes.

Explain the relationship between marginal cost and average total cost curves.

Draw the marginal cost, average variable cost and marginal revenue curves for a firm that will shut down in the short-run.

Draw the marginal cost, average variable cost and marginal revenue curves for a firm that will stay in business in the short-run.

If, as the quantity produced increases, a production function first exhibits increasing marginal product and later diminishing marginal product, what will be the shape of the corresponding marginal-cost curve?

In the long run, if a very small factory were to expand its scale of operations, it is likely that it would initially experience

a. Economies of scale
b. Constant returns to scale
c. Diseconomies of scale
d. An increase in average total costs

Suppose you have a job in production management. A portion of your costs are:

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Average Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>500</td>
<td>200</td>
</tr>
<tr>
<td>501</td>
<td>201</td>
</tr>
</tbody>
</table>

Your current level of production is 500 units. All 500 units have been ordered by your regular customers.
The phone rings. It’s a new customer who wants to buy one unit of your product, offering $450 for the unit. You would have to increase production to 501 unit. Should you do it?

Compare marginal cost with marginal revenue. Total cost at 500 units is $200 \times 500 = 100,000$. Total cost at 501 units is $201 \times 501 = 100,701$. So marginal cost is 701. You should not do it, as $701 > 450$.

Sunk Costs

A sunk cost is a cost that cannot be recovered, regardless of what one does.

When a firm decides to shut down in short run, it ignores sunk costs.

In this case, sunk costs are the fixed costs. The firm cannot recover them whatever it does. Thus it ignores these costs when deciding how much to produce.

Why do restaurants stay open for lunch even if business is slow at lunchtime?

The firm has already committed to pay the fixed costs for rent of building, kitchen equipment, tables, plates, etc. These are sunk costs.

When deciding whether to serve lunch, only variable costs are relevant – cost of waiters, cooks. The restaurant will shut down at lunchtime if and only if variable cost exceeds revenue from lunchtime customers.

Similarly, owner of a miniature golf course must decide whether to stay open off-season. Does the revenue from the few customers they will get exceed the variable costs paid to staff, etc.? The fixed costs – costs of building the course, cost of the land – are sunk, and therefore irrelevant.

Firm’s long-run decision to exit or enter a market

In the long run, when a firm exits the market, it will save its fixed costs.

Thus a firm exits the market if its total revenue is less than its total costs.

Exit if $TR < TC \iff TR/Q < TC/Q \iff P < ATC$.

A firm exits the market if the price of its good is less than the minimum of average total cost.
Similarly, a firm that is considering entering a market will enter if price exceeds expected minimum average total cost of production.

The competitive firm’s long-run supply curve is the portion of the marginal cost curve that lies above average total cost, and zero below the minimum of average total cost.

Profit

To measure profit on the graph, use:

$$\Pi = TR - TC = (TR/Q - TC/Q) \times Q = (P - ATC) \times Q.$$
Therefore profit or losses are given by the rectangles in the graphs:

The left graph shows a firm earning positive profits. At the quantity where marginal revenue equals marginal cost, price exceeds average total cost. So profit equals \((P - ATC) \times Q > 0\).

The left graph shows a firm earning negative profits. At the quantity where marginal revenue equals marginal cost, price is lower than average total cost. Therefore profit equals \((P - ATC) \times Q < 0\). This firm would exit the market if the price stays this way for the whole long-run period.

Supply curve in a competitive market

Consider two cases:

1. A market with a fixed number of firms

2. A market with varying number of firms
The fixed number of firms assumption can hold over short periods of time. The variable number of firms assumption is appropriate for longer periods of time.

**Short run**

A market has 1000 identical firms (their costs are all identical, product is identical).

For a given price $P$, each firm supplies quantity $Q$ such that $MC(Q) = P$.

The market quantity supplied equals the sum of all the quantities supplied by the firms. Sum the graphs of the firms’ supply curves horizontally to get the market supply curve.

Since there are 1000 identical firms, the sum of the quantities at a given price will be 1000 times the quantity for one firm at that price.

**Long run**

In the long run, entry and exit is possible.

Again, all firms have the same cost curves or potential cost curves.

If firms in the market are making profits, other firms will enter the market.

This entry will increase the quantity of good supplied.

This drives down the price, and profits decrease.

If firms in the market are making losses, some of them will exit.

This decreases the quantity of the good supplied.

Prices, and thus profits, increase for the firms that have not left the market.

When all firms and potential firms have identical cost curves: Due to the processes of entry and exit, firms remaining in the market must be making zero economic profit.

Firm’s profit is $\Pi = (P - ATC) \times Q$. 
For this to be zero, \( P - ATC \) must equal zero.

So at the quantity \( Q \) that the firm produces at, average total cost must equal the price. At this quantity also marginal cost equals price. So marginal cost must equal average total cost.

Then, since the marginal cost curve intersects the average total cost curve at the minimum of average total cost, the firm must be producing at the minimum of average total cost.

The long-run equilibrium of a competitive market with identical firms and free exit and entry has all firms operating at their efficient scale.

In a long-run equilibrium, \( P = MC = ATC \). Because of zero profits, new firms have no incentive to enter the market, but existing firms have no incentive to leave it.

The long-run supply curve for the market can be determined from the equilibrium condition.

There is only one price at which zero profit is made. That is the minimum of average total cost. At any price above it, positive profits would be made. Then entry would occur, leading to an (infinite) increase in supply.

At any price below it, negative profits would be made, and all firms would exit the market – there would be zero supply.

Therefore the long-run supply curve is horizontal at the minimum of average total cost.

Why do competitive firms stay in business when they make zero profit?

Profit equals total revenue minus total cost, where total cost equals all opportunity costs of the firm. This includes the opportunity costs of the owners of the firm.

When profits are zero the owners of the firm are getting the opportunity cost of the time and money they put into the firm paid back as revenue. They are indifferent between running the firm and taking the next-best opportunity to invest their time and money in.

Shift in demand in short-run and long-run
Suppose a market begins at long-run equilibrium. Firms earn zero profit, price equals minimum of average total cost.

Then tastes for the good change so that demand increases. The short-run equilibrium moves up.

Each firm’s supply curve is part of their marginal cost curve. So how much they increase production by depends on the marginal cost curve.

In the new short-run equilibrium price exceeds marginal cost. Firms are making positive profit.
MC ATC
Firm Market
Short run supply Demand
P QQ P

P Q Q
In the long run, other firms encouraged by positive profit to enter the market.

The number of firms in the market grows, causing short-run supply curve to shift to right from $S_1$ to $S_2$. This causes price to fall.

Price goes back down to minimum of average total cost. At this point profits are zero so firms stop entering.

New long-run equilibrium, at same price as originally, but higher quantity due to more firms being in the market.
Why might long-run supply curve slope upward?

When there are no barriers to entry and exit, large number of potential entrants, each facing the same costs, long run supply curve is horizontal at minimum of average total cost.

When one necessary resource for production in limited supply, or cost curves of all firms not the same, long-run supply curve may be upward-sloping.

1. Suppose a necessary resource, such as land, is in limited supply. As more people become farmers, price of farmland bid up. This raises cost to all farmers in the market (even if a farmer owns their land, when land rises in value, the opportunity cost of owning it is higher).

Therefore when demand for farm products increases, quantity supplied increases due to more firms entering the market → cost of land increases → price of farm products rises.

Thus the long-run supply market curve is upward-sloping.
2. Suppose firms have different costs. Consider market for house painters. Costs vary because some people have better alternative possibilities for their time and some paint faster than others.

For given price, painters with lower costs more likely to enter market than painters with higher costs. Then to increase quantity supplied, the price must be increased for painters with higher costs to enter market.

The long-run market supply curve slopes upward.

When firms have different costs, some firms will earn positive profits even in long run. The marginal firm (the firm that would exit the market if price were any lower) makes zero profits.

But firms whose costs are lower than those of the marginal firm make positive profits.

In general, because firms can enter and exit more easily in the long run than in the short run, long run market supply curve is typically more elastic in long-run than short-run market supply curve.