Chapter 8. Competitive Firms and Markets

We have learned the production function and cost function, the question now is: how much to produce such that firm can maximize his profit?

To solve this question, firm has to make sure he can sell all he produces. But this really depends on the demand curve, and its belied about how other firms in the market will behave, the ease with which firms can enter and leave the market and the ability of firms to differentiate their products from those of their rivals. In this chapter, we look at a competitive market structure.

1. Competition and profit-maximization

Competition means that there are two or more firms in the same business. Economists use the term “perfect competition” to describe an idea market structure.

In a perfectly competitive market, firms are price-takers. If each firm produces a small share of the total market output and its output is identical, then each firm is a price taker.

- The firm cannot affect the “market price.”
  This simply says that firm has no power to raise its price. If it does so, the firm is unable to sell output because consumers will buy goods from others.

- The firm’s demand curve is horizontal.
  If price is set at p, then firm can sell as much as it wants; if above p, because of infinitely elastic demand, a small increase in price will cause its demand to fall to 0; Firm is not willing to set price below p either because he will lose profit by doing so.

Textbook example:
There are 40,000 apple farms in the US. One of them charges a different, higher, price than the others will result in no-sale. Consumers buy the same apples from others. A farm also has no incentives to decrease the price since this will not increase profit.

- A perfectly competitive firm faces a horizontal demand curve.
Firms are price-takers in the competitive market if
- Identical products (homogeneous product): consumers can substitute among them perfectly.
- Buyers and sellers know all price charged by all firms → full information.
- Free entry and exit in the market: who wants to sell can sell.
- Low transaction cost: can easily find other partners to trade.

[2] Profit maximization
We have learned that
\[ \pi = R - C \]
And the cost is economic cost which includes all opportunity cost.

A firm considers two decisions:
Stay in business or not? -- (YES) \rightarrow How much to produce?
-- (NO) \rightarrow Shut down

- [Suppose stay in business]
  How much should it produce?
  Let’s see the condition for maximizing profit:
  Marginal profit, \( MP = 0 \)  \hspace{1cm} (Rule 1)
  The reason is that if \( MP > 0 \), you want to increase output;
  \( MP < 0 \), you want to decrease output.
  Only when \( MP = 0 \), you have no room to increase profit.
  (The profit curve has an inverse U-shape.)

  Also,
  \[
  MP = \frac{\Delta (R - C)}{\Delta q} \\
  = \frac{\Delta R}{\Delta q} - \frac{\Delta C}{\Delta q} \\
  = MR - MC
  \]
  So, a firm wants to produce at
  \[
  MR = MC \hspace{1cm} (Rule 2)
  \]

- [Shut down or not?]
  1. In the Long-Run
     If the maximum profit \( \pi^* = R^* - C^* < 0 \), shut down;
     \( > 0 \), stay in business;
     \( = 0 \), doesn't matter.

  2. In the Short-Run
After figuring out the maximum profit when it stays in business, which is \( \pi^* = R^* - C^* = R^* - VC^* - FC \), a firm will compare the Revenue and the Variable Cost.

Option 1: shut down
Earn 0 and pay FC: \( \pi = -FC \).

Option 2: in business
Earn \( R^* \) and pay FC + VC*: \( \pi = pq^* - FC - VC(q^*) \).

\( \rightarrow \) The Fixed Cost is sunk cost (not avoidable) in the short-run; it is already paid and cannot be recovered.

Option 1 is more profitable if and only if
\[
pq^* - FC - VC(q^*) < -FC
\]
\[
pq^* < VC(q^*)
\]

So, it is better to

| Stay in if \( pq^* > VC(q^*) \); this means the revenue is enough to cover the Variable Cost. |
| Shut down if \( pq^* < VC(q^*) \); this means the revenue is not enough to cover the Variable Cost |

If \( R^* = VC^* \), it does not matter.

So,

\[ \text{Stay in business or not?} \]

\( \text{YES (LR: } \pi^* > 0; \text{ SR: } pq^* > VC(q^*) \Rightarrow \) \text{ How much to produce? - at } MR = MC \]

\( \text{NO (LR: } \pi^* < 0; \text{ SR: } pq^* < VC(q^*) \Rightarrow \) Shut down \]

2. Competition in the short-run
2.1 Short-run profit maximization

[1] Optimal output level

We have seen the MC curve. Let’s figure out MR.

A competitive firm faces a horizontal demand curve; this means it can sell its product at a constant price \( p \) and the revenue is \( pq \). So,

\[
AR = R/q = p;
MR = p.
\]

These will be helpful. Moreover, the average profit
\[
A\pi = \pi/q = (R - C)/q
= AR - AC
= p - AC
\]

The profit-maximizing condition (in the short-run) is

\[
MC = p
\]
See Figure 8.3:

1. The firm maximizes profit at point e (where MC equals p). We will call this firm’s equilibrium since it does not want to change.

2. The Total Revenue is the big rectangle \((8\times 284)\); \(p\times q\).

3. The Total Cost is the low rectangle \((6.50\times 284)\); \(AC\times q\).

4. The Total Profit is the yellow rectangle (the big one minus the white one) \(((8-6.50)\times 284)\); \(\Delta \pi \times q\).

5. The distance between \(p\) and \(AC\) at e is the average profit
   \[p > AC: \text{positive profit} \]
   \[p < AC: \text{loss} \]

From panel (b), we can see that firm chooses its output level to maximize its total profit rather than the average profit per ton. By producing 140 thousand tons, where average cost is minimized, firm could
maximize its average profit. If firm produces 284 thousand tons of lime, although firm loses $0.50 ($6.50−$6) in profit per ton, it gains by selling more output. And the gain is bigger than the loss, so firm is maximizing its profit at 284 thousand tons.

Application: how does a cost shift affect profit-maximizing behavior (Problem 8.1, p. 236).
Q: What happen to the optimal output when government imposes a specific tax of $\tau$:

Solution:
(1) Total cost $^a =$Total cost $^b + \tau q$
\[ \Rightarrow \quad MC^a = MC^b + \tau \]
and
\[ \Rightarrow \quad AC^a = AC^b + \tau \]

(2) Originally, the firm has $MC_1$ and $AC_1$ and its equilibrium is $e_1$. The tax will shift both the $MC$ and $AC$ up by $\tau$. And the new equilibrium is $e_2$. In response to tax, firm produces $q_1 - q_2$ fewer units of output.
(3) Since firm sells less output, and average cost has been increased, the profit it earns now drops. Firms sell less and make less profit per unit.

(4) After-tax profit is \( A = \pi_2 = (p - AC(q_2^*)) \times q_2^* \)

Before-tax profit is \( A + B = \pi_1 = (p - AC(q_1^*)) \times q_1^* \)

Profit falls by area B due to the tax.

[2] Short-run shut-down decision
We have shown previously that the firm will shut down if
\[
pq = R^* < VC^* = AVC*q
\]
\[p < AVC\text{ (at equilibrium } e)\]

See it in the picture (Figure 8.4): make a loss but still in business.

Figure 8.4

1. The rectangle between AC and p at e: loss (A).
2. Where is the FC: the rectangle between AC and AVC at e (A+B)
3. The rectangle between AVC and p at e: the part of revenue goes to cover FC (B). Note that VC is totally covered.

Let’s check the shut-down rule again.
Shut down: lose \( A + B \) (fixed cost)
Stay in: lose A (part of fixed cost)

[3] To sum up:

<table>
<thead>
<tr>
<th>Condition</th>
<th>Optimal output</th>
<th>Profit</th>
<th>Shut-down</th>
</tr>
</thead>
<tbody>
<tr>
<td>p &gt; AC, positive profit</td>
<td>MC up → q down</td>
<td>AC up → π down</td>
<td>AVC up → may shut down</td>
</tr>
<tr>
<td>AVC &lt; p &lt; AC, loss but stay in business.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>p &lt; AVC, shut down</td>
<td>MC same</td>
<td>AC up → π down</td>
<td>AVC same</td>
</tr>
</tbody>
</table>

Note that there are three criteria for three things.

- Optimal output: \( P = MC \)
- Profit: \( P - AC > 0 \)
- Shut-down: \( P < AVC \)

Practice: If we find the fixed cost is increased twice, will that change firm's production decision?

Answer: No. Because firm's production decision has nothing to do with Fixed cost. Only depends on Variable cost.

Application: will an increase in cost affect firms behavior?

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<td>AVC up → may shut down</td>
</tr>
<tr>
<td>(Specific tax)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fixed cost</td>
<td>MC same</td>
<td>AC up → π down</td>
<td>AVC same</td>
</tr>
<tr>
<td>(Franchise fee)</td>
<td></td>
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2.2 Short-run supply curves

[1] Short-run firm supply curve

A firm’s supply curve describes the quantity it wants to supply at a given price. We can use a firm’s profit-maximization behavior to derive the supply curve (Figure 8.5).
For a given price, a firm will produce and sell at an output level where $P = MC$. So the firm’s supply curve is exactly the MC curve. However, if the price is too low, the firm will shut down and produce nothing.

The supply curve is “the part of MC curve above AVC.” Note that this “cut-off” point is also the lowest point of the AVC.

[2] From one firm’s supply curve to the market supply curve

Case I: Identical firms (Identical cost → identical firm’s supply curve)
The market supply curve is the sum of all firms’ supply curves. Let’s see an example (Figure 8.8).
This industry has five firms. Market supply $Q = n \times Q_i$, where $Q_i$ is individual firm's supply. When price is equal to $5$, each firm produces 50 units of output. So there will be 250 units of output in the market. Similarly, we can get the market supply for all possible prices. And the market supply curve is $S^5$. The market supply curve is flatter than individual's supply. And when $n$ increases, market supply will get flatter and flatter. As the number of firms grows very large, the market supply curve approaches a horizontal line at $5$.

Case II: Different firms: cost functions will be different $\rightarrow$ individual supply curve and shut-down point will be different $\rightarrow$ Not all firms produce at every price.
When price is below $6, only firm 1 will produce. So the market supply curve is exactly the supply curve of firm 1 when price is between $5 and $6. When price rises to $6, firm 2 starts to produce, and the market supply curve will be the sum of firm 1’s and firm 2’s supply curve. Therefore we get this stairlike supply curve. As price increases, supply curve gets flatter and flatter.

2.3 Market equilibrium and firms’ behavior
Now keep in mind that there are numerous firms. We can assume that they are all identical.
In the graph below, Panel (a) shows one firm’s cost curves and panel (b) shows the market S-D curves.
1. A demand shock (Figure 8.9)

**Original equilibrium:** The market equilibrium is at $E_1$. Market equilibrium price is $7, while the market equilibrium quantity is 1,075. At price $7, each firm produces at $q_1=215$. We can see that market equilibrium quantity is equal to individual's quantity multiplied by the number of firms in the market ($1,075=215*5$).

In this case, each firm is earning profit=$(7-6.20)*215=172$.

**After the shock:** demand shifts to left. New market equilibrium is the intersection of new demand curve and supply curve, i.e., $E_2$. The new market equilibrium price is $5, while the market equilibrium quantity is 250. When price is $5, each firm will produce 50 units of output. So, again, we have $250=5*50$.

But for this case, firm doesn’t have a positive profit. Each firm loses $5*50-6.97*50=-98.5$. However, if firm chooses to shut down, he also loses $-98.5$. Firm is indifferent in shutting down or producing. We assume firm will produce if he is indifferent.

2. Effect of a specific tax
Originally, all firms produce at $e_i$ and the market equilibrium is $E_1$ with price $p_1$. Each firm is producing $q_i$ and market equilibrium quantity is $Q_1 = nq_1$. If a specific tax is imposed, the $MC$ and $AVC$ will both moves up (shifts to the left). This shifts the market supply to the left: $S + \tau$ and a new equilibrium price is determined ($E_2$ and $p_2$). When the price rises, because $p_2 > \min\{AVC\}$, each firm will produce and produce less output: $q_2$ and market equilibrium quantity also falls to $Q_2 = nq_2$.

3. Competition in the long-run
3.1 Long-run firm supply curve
Still, a firm wants to produce at $p = MC$. The difference is that it can adjust the level of capital so that there is no fixed cost. And a firm shut down in the LR if $p < AC$ (note that there is no fixed cost in the LR). Let’s see a firm’s LR supply curve in Figure 8.11 first.
Comparing SR and LR profit-maximizing (Figure 8.11):
This firm's optimal output level is to produce 110 units of output (in the LR). Suppose it has the “right plant size”, it will choose 110. What if the firm made a wrong decision and is currently at a wrong plant size?

At a wrong plant size less than the long-run optimal:
Suppose the price is fixed at $p$. The firm has a fixed capital level and the corresponding SR cost curves are shown. It will produce at $q_s = 50$ and earn profit = area A. This is the best it can do. Given enough time, the firm can change capital and produce according to the LR cost curves. It will expand plant size and produce $q_L = 110$. This leads to a higher profit = area B.

→ We have seen that LR cost is lower than SR cost. Here we see LR profit is higher than SR profit. This comes from two things: given enough time, a firm (at a wrong plant size) may further reduce cost and increase output.

3.2 Long-run Market supply curve
[1] Enter and exit
In order to learn the LR market supply, we need to analyze firms’ entry and exit. Since the change in quantity may come from changing number of firms as well as the output change in each firm. Therefore, before adding all the relevant firm supply curves to obtain the market supply curve, we have to decide how many firms are in the market at each possible price.

When will a firm enter?
\( \pi > 0; \) enter.
\( \pi < 0; \) leave the market.
We will see several cases of entry.

Case 1: Identical firms, free entry and constant input price (Figure 8.12)

![Figure 8.12](image)

All potential firms have the same cost curves. There are many potential firms that may enter the market. Suppose there are a few firms in the market already and they have the same supply curve S1.
If the price is lower than 10, no one wants to produce \( \rightarrow \) leave.
If the price is higher than 10, there is a positive profit \( \rightarrow \) attract new firms \( \rightarrow \) more output will be supplied \( \rightarrow \) price will be driven down \( \rightarrow \) profit=0 \( \rightarrow \) firms will be indifferent in entering or not.
So, as long as the price is at 10, any quantity can be supplied by having more firms. This means a horizontal supply curve. Note the firms all produce at the lowest point of AC.

Other cases will have upward sloping supply curves.

Case 2: Entry is limited
No entry means the changes in quantity can only come from the output changes of each firm. This is similar to short-run supply curve where the number of firms is fixed. The market supply curve will be upward sloping.

Case 3: Firms differ
When firms differ and joins market at different prices, the market supply curve is upward sloping. Firms with relatively low minimum long-run average cost are willing to enter the market at lower prices than others. And this will results in an upward-sloping market supply curve. But the upward-sloping LRS is because of differences in costs can happen only if the amount of lower-cost firms is limited. If unlimited, we will never observe any highest-cost firms producing.

For example, there are many countries that produce cotton. Each country has numerous farms with identical cost curves. But the technology and cost among countries are different. The world cotton supply curve looks like the one above on page 253 in textbook. It has several steps. Each
step means that all the quantities in the world market is supplied by farms in one country. At a low price, Pakistan farmers supply cotton (this price is too low for other countries). The farms are identical, so this segment is horizontal as in case 1. When all the farms are engaged in production, Pakistan cannot supply more. As the price increases, Argentina will join the market and start another horizontal segment.

Case 4: Input prices vary
In the above cases, we assume input prices are constant. If input price varies with the output, then when firms produce more and inputs are in demand, input prices can be driven up.

This depends on whether the industry hires a large portion of the input.
- The computer industry uses steel to make computer cases, the changes in output will not affect world steel price.
- The construction industry, on the other hand, buys a major portion of steel. The steel price will go up if more construction is demanded.

We assume identical firms for simplicity.

1. Increasing-cost market: Input prices rise with output (Figure 8.13)

![Figure 8.13](image)

Originally, free entry makes all firm producing at the lowest part of AC.
To supply a higher quantity → need more inputs → input prices up → cost curves up → free entry leads to lowest point of new AC → upward sloping market supply curve.

2. Constant-cost market: case 1 (Figure 8.12)

3. Decreasing-cost market: Input prices fall with output (Figure 8.14)

![Figure 8.14](image)

The reason is that the input may not be mass-produced. As the output goes up, the demand for the input increase, mass-production reduced the input price.

To supply a higher quantity → input prices down → cost curves down → free entry leads to lowest point of new AC → downward sloping market supply curve.

To sum up the firms’ and market’s supply curves in the SR and LR:

**Short-run:**
1. $S_{firm}$ is the part of MC above AVC.
2. $S_{market}$ is the sum of all firms, $S$ curves and number of firms is fixed.
3. The change of market comes from the change in each firm’s production, not from the number of firms.

**Long-run:**
1. $S_{firm}$ is the part of LRMC above LRAC.
2. When there is free-entry,
   (i) firms produce at the lowest point of LRAC, which means zero-profit,
   (ii) $S_{market}$ is not the sum of firms' $S$ curves.
3. In an identical-firm free entry model
   (i) Increasing-cost market: upward sloping $S_{market}$
   (ii) Constant-cost market: flat $S_{market}$
   (iii) Decreasing-cost market: downward sloping $S_{market}$
4. The change in market output can only be caused by the change in the number of firms.

3.3 long-run competitive equilibrium.
The intersection of the long-run market supply and demand curve determines the long-run Competitive Equilibrium. We have known that with identical firms, constant input prices, and free entry and exit, the long-run Competitive Market supply is horizontal at minimum long-run average cost, so the equilibrium price equals the minimum of long-run average cost. A shift in the demand curve affects only the equilibrium quantity and not the equilibrium price.

Since the market supply curve is different in the short run and in the long run, the equilibrium will also be different for these two. The relationship between SHORT-RUN Competitive Equilibrium and LONG-RUN Competitive Equilibrium depends on where the market demand curve crosses the short-run and long-run market supply curves.

Let’s use the graph below to illustrate the relationship between SR and LR. We assume that the firm uses the same plant size in SR and LR so that the minimal average cost is same in both cases.
Assume there are 20 firms in the market originally.

Step 1: derive the SR supply curve and market supply curve.
Firm's supply curve is the part of MC above minimum of average variable cost: $7.
Market supply curve is the sum of all 20 firms' supply curve, which is $S^{SR}$.

Step 2: derive the LR supply curve.
Firm's long-run supply curve is the part of MC above the minimum of average cost: $10. And the market supply curve will be the horizontal line $S^{LR}$ at price $10$.

Step 3: If the market demand curve is $D^1$, then SR equilibrium is located at point $F_1$.
At $F_1$, equilibrium price is $7$, and equilibrium quantity is $2,000=20*100$. Each firm is earning a negative profit, but since price equals to the minimum of average variable cost, firms will stay and produce.
The long-run equilibrium is located at point $E_1$, where equilibrium price is $10$, while the equilibrium quantity is $1,500$.
At $E_1$, each firm is producing $150$ while the total output is $1,500$, so there are only $10$ firms in this market.
Half of the firms exit the market because in the short-run, when the market price equals to $7$, every firm is earning a negative profit and in the long-run, some of firms will exit. When some firms exit, market price rises to $10$, and market output falls.
Step 4: If the demand curve expands to $D^2$, the short-run equilibrium is at point $F_2$ and long-run equilibrium is at point $E_2$.

In the short-run, the market equilibrium price is $11$, and the market equilibrium quantity is 3,300. Each firm is producing 165 and earns a positive profit.

In the long-run, this positive profit will attracts some firms to enter this market. When there are more firms in this market, supply will go up, and market price will fall to $10$, where firms are indifferent between entering or not. Each firm will produce 150 at price $10$.

We can derive the number of firms in the market: $Q/q = 3,600/150 = 24$. So 4 more firms enter this market.

Practice:
If government starts collecting a lump-sum franchise tax of $\tau$ each year from each identical firm in a competitive market with free entry and exit, how do the long-rum market and firm equilibrium change?

Solution:
Step 1: $TC^d = TC^s + \tau \Rightarrow AC^d = AC^s + \tau/q$ and $MC^d = MC^s$

Step 2: put the new MC and AC on the graph.

Before the tax, the equilibrium is at point $E_1$. Market equilibrium price is $p_1$ and market equilibrium quantity is $Q_1$. Each firm produces $q_1$ and there are $n_1$ firms in the market.
After the tax, average cost shifts up by $\tau/q$ while marginal cost stays at the same place. The minimum of average cost now moves to point $e_2$, and this will shift up the market supply curve to $p_2$ because long-run supply curve is horizontal at the minimum of average cost.

Step 3: The new market equilibrium is at point $E_2$. The new market equilibrium quantity is $Q_2 < Q_1$ and the new market equilibrium price is $p_2$.

Step 4: When there is a lump-sum tax, each firm will produce more: $q_2 > q_1$. But we know that the new market quantity is less than before, so this implies there is less firms in the market.

$$n_2 = Q_2/q_2 < n_1 = Q_1/q_1$$

So there are fewer firms remaining in the market, but each firm is producing more.