

Section Exercise 4

1)

- a) What is a production function? With the aid of an example, what can change the shape of a producer's production function?

A production function tells us the maximum amount of output that a producer could make for each given amount of inputs. Its shape can be changed by, for example, technological progress. For example maybe there is an innovation in warehouse logistics that enables the same amount of workers and warehouse space to store or retrieve more inventory per hour than before. This would have increased the 'height' of the production function for each combination of inputs.

- b) Say that a sandwich company uses two inputs, 'labor' and 'bread', to make its output. Explain what it would mean for this producer to have (i) diminishing returns to labor, but (ii) constant returns to scale.

Diminishing returns to labor means that the amount of extra sandwiches that you'd get when adding extra units of labor would be smaller when you have more labor. Constant returns to scale means that if you scaled up both inputs, labor and bread, by the same factor, you'd get exactly that factor more sandwiches in extra output.

- 2) Jim's Haggis is a profit-maximizing haggis producer in the perfectly competitive haggis industry. Their marginal cost is given by $8Q$, where Q is quantity produced, and the price of their output is \$40 per unit.
- a) Find this producer's profit-maximizing choice of output. Explain the equation that you used. Do we know whether Jim's Haggis is profitable? Why or why not?

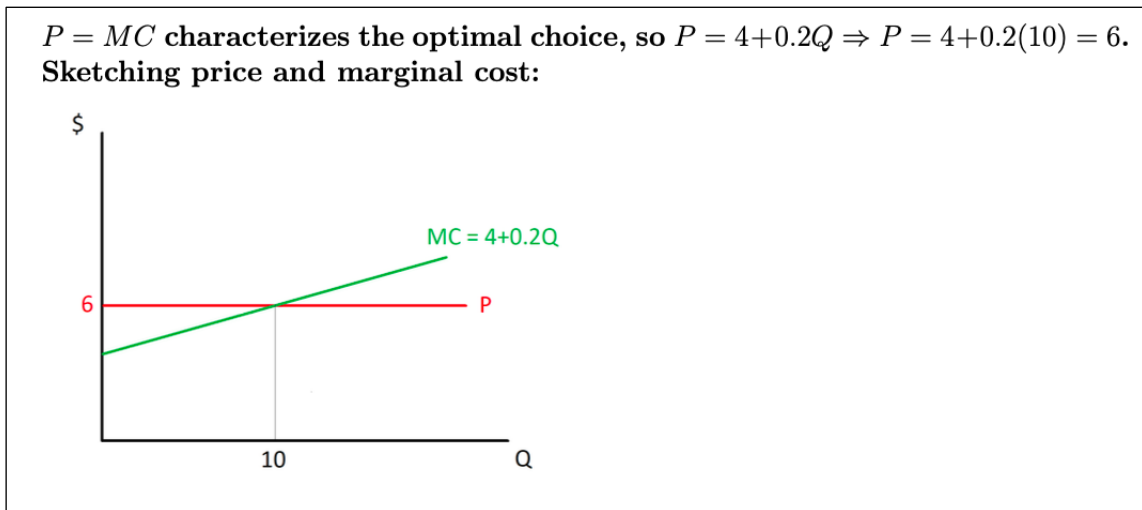
For a profit-maximizing firm, $MR = MC$; for a firm in a perfectly competitive industry, MR is just the price p . So: $p = MC \Rightarrow 40 = 8Q \Rightarrow Q = 5$. This equation captures the idea that the profit-maximizing firm should produce up to the point where the extra cost to produce the next unit is more than the price it can be sold for, since then they'd lose money on that unit. Or equivalently, they should keep producing more only as long as the extra revenue they'd get from producing the next unit exceeds the cost of producing it.

We don't know if Jim's Haggis is profitable because we don't know enough about costs. Marginal costs tell us nothing about fixed costs (since fixed costs don't change with quantity produced), so we can't say whether total revenue is bigger or smaller than total cost; all we know is that there's no other production quantity that would be *more* profitable than $Q = 5$.

- b) Jim is planning to stay in business for now, but to shut down once the lease on his kitchen space expires. What do we know now about the profitability of Jim's Haggis and the size of his various production costs? Explain.

Now we know more. We know that Jim's Haggis is making a loss (profit less than zero), since he's planning to shut down. We know, therefore, that his average cost is bigger than the price, \$40 (at his optimal choice of $Q = 5$). We also know that his average variable cost is less than the price, \$40, since he is choosing to produce stuff in the short run. He's able to cover his variable costs, so he makes less of a loss by producing some stuff (while waiting to shut down in the long run) than he would if he produced nothing. The lease here is acting a fixed cost: he has to pay it for now (and the fixed costs are big enough that he's making a loss) but when it expires—when the fixed costs become variable—he will take the opportunity to shut down.

- 3) A profit-motivated producer in a competitive industry has a cost function given by $C = F + 4Q + 0.1Q^2$ (where F is a number bigger than zero), which means that their marginal cost is given by $4 + 0.2Q$. Their profit-maximizing choice of output is $Q^* = 10$.
- a) What is the price per unit of output in this industry? How do you know? Sketch a diagram to illustrate the two sides of the equation that you used to get your answer.

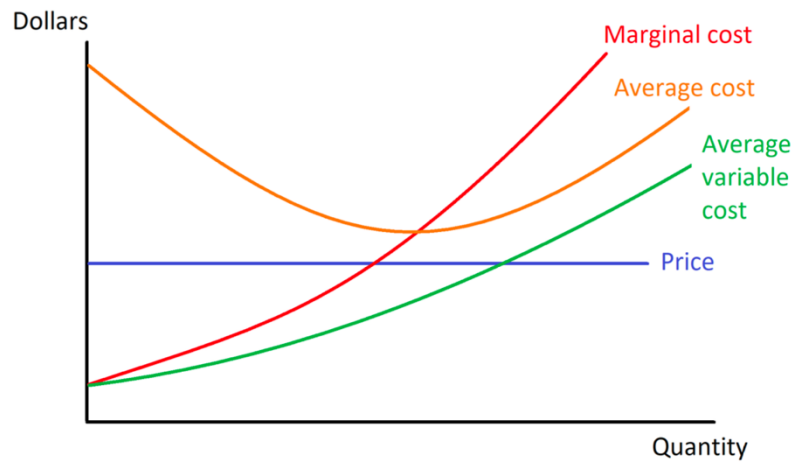


- b) For what values of F will this producer choose to shut down in the long run, and for which values of F will they choose to stay in business in the long run? Explain your answer. If F is in the 'shut down in the long run' range, how do we know that it's better in the short run for the producer to produce some output rather than none?

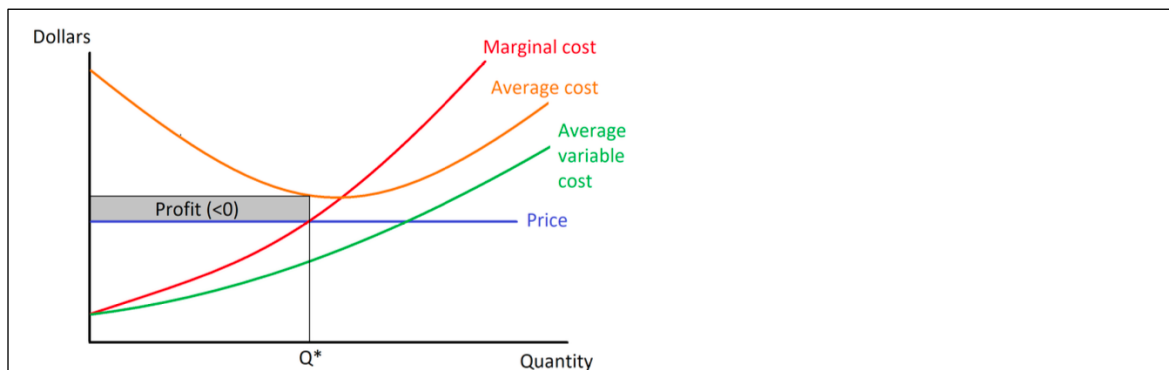
The producer will shut down in the long run if they are making negative economic profit; we've assumed they're profit-motivated, and if economic profit is negative they could earn more from their resources by using them elsewhere. So let's check: $\pi = R - C = (P \times Q) - (F + 4Q + 0.1Q^2)$ and so at $P = 6$, $Q = 10$ we have $\pi = (10 \times 6) - (F + 4(10) + 0.1(10^2)) = 60 - F - 40 - 10 = 10 - F$. Profit is therefore less than zero (and so they will choose to shut down in the long run) if the fixed cost of production $F > 10$ and profit is bigger than zero (and so they will choose to stay in business in the long run) if $F < 10$.

In the short run when $F > 10$ the question is whether the producer covers their variable costs at $Q = 10$; since the fixed costs are sunk and must be paid no matter what, the producer will make less of a loss by producing some output rather than none so long as their variable costs are covered. Two ways to check whether that's true. First, if we ignore fixed costs the rest of the profit function is positive—only fixed costs are driving profit negative when $F > 10$. Second, we can compare the price $P = 6$ to average variable cost at $Q = 10$. $AVC = 4 + 0.1Q$, which at $Q = 10$ is $AVC = 5$. Since price exceeds average variable cost, profit per unit is positive if we ignore fixed costs. This producer will therefore produce something rather than nothing in the short run.

- 4) Consider a model of a profit-motivated producer in a perfectly competitive industry. The following diagram shows information about their costs and price:



- a) Show on the diagram the producer's optimal choice of output. Explain why this is their optimal choice (including explaining any jargon in simple language). Add to the diagram an area that represents the producer's profit. Is that profit positive or negative, and how do you know?



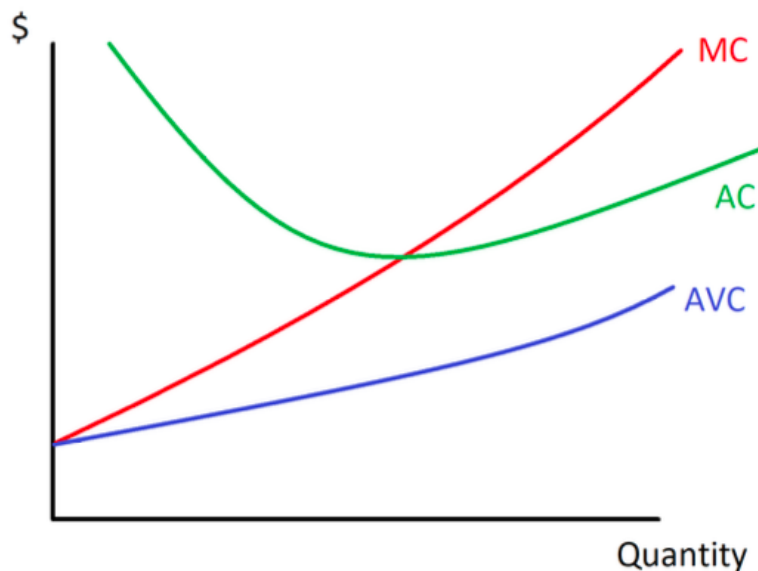
The producer's optimal choice, Q^* , occurs where $p = MC$ in the diagram. For the perfectly competitive producer, each extra unit produced yields revenue equal to the price of the output in the market (that is, their marginal revenue is always equal to the price p). When this exceeds the extra cost of producing that extra unit, producing that unit increases profit. The producer, being profit-motivated, therefore produces up until the point where price no longer exceeds the marginal cost of producing the next unit.

The producer's profit is shaded in the diagram and it is negative. This is because at their optimal choice of output, cost per unit produced (average cost) exceeds the price received per unit produced. (Notice that this is still better than producing nothing at all, because we can see that the variable cost per unit produced is lower than price—if we set aside the fixed cost of production, which must be paid in any case, the producer more than covers the variable cost of production by producing Q^* and so makes less of a loss than they would if they produced zero.)

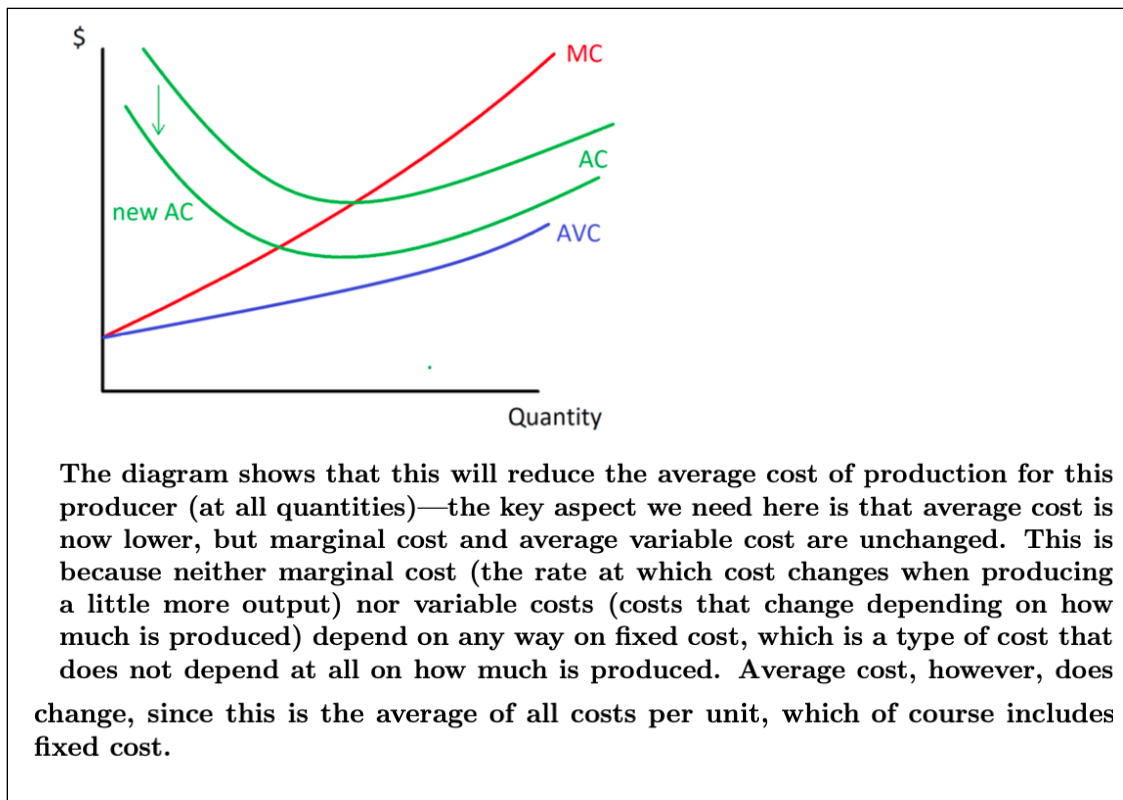
- b) In the long run, what does the model of perfect competition predict will happen to the price and the number of producers in this industry? Explain why, with reference to the appropriate assumptions of the model.

The model predicts that the number of producers in this industry will fall. Since producers are making negative economic profit, in the long run (that length of time when they can exit the industry and incur no further costs of any kind) they will prefer not to be in the industry at all. As producers exit, the price in the industry is predicted to rise, as the supply curve moves to the left due to less quantity being supplied for any given price. So: in the long run we would expect to see a higher price and a reduction in the number of producers, due to the free entry and exit assumption of the model of perfect competition.

- 5) The diagram below shows the cost structure (average cost, marginal cost, and average variable cost) for a representative firm whose product is sold in a perfectly competitive market. The market is currently in long run equilibrium.

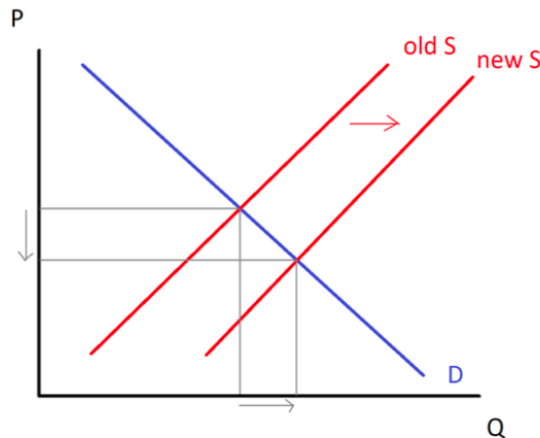


- a) Say that there is a technological innovation that reduces the fixed cost of production in this industry (and has no other effect on the market for this product). Add to the diagram to show how this will affect the cost structure for this firm. In a few sentences, explain in simple terms what your diagram shows, including a brief explanation of these various types of cost.



- b) Explain what will happen in the long run in this industry and why (all else being equal). Sketch a supply and demand diagram to support your answer.

First, we know that before the change in fixed cost, the market was in long run equilibrium. That means that each producer was making zero economic profit. After the change to fixed costs, each producer will therefore be making *positive* economic profit in the short run (I didn't ask for this, but check if you can figure out why that is by adding to the cost diagram to visualize the new amount of profit!). This means that in the long run we will see entry by new producers into this industry in response to the opportunity for positive economic profit. This will shift the supply curve to the right (more quantity is supplied for each possible price), and so in the long run we will reach a new equilibrium with (i) more producers, (ii) a higher quantity produced overall, and (iii) a lower price than in the previous long run equilibrium. Ultimately this process will end with a new long run equilibrium with, once again, zero economic profit for all producers.



(Again, and as always, I think your answer didn't have to necessarily perfectly match mine here. The key points are (i) positive profits now leading to (ii) entry which means (iii) supply shifts right and (iv) this means price falls. There are lots of things you *could* say about the new equilibrium or the adjustment process, so we don't necessarily need you to mention every single thing.)