Week 13 notes

Reading: Chapter 12

The difference between fixed costs and variable costs was addressed at the end of the week 12 notes. Look at Table 4 below and fill in the other columns.[1] Unlike in the week 12 notes when the input (namely workers) was increased by 1 in each row of the table, here the output (represented as Q) is increased by 1 in each row of the table. Table 4 is an example of realistic cost structures that a firm could face in producing output. Below the table, each column is discussed in more detail.

Table 4

Q	**FC**	**VC**	**TC**	**AFC**	**AVC**	**ATC**	**MC**
0	3	0		n/a	n/a	n/a	n/a
1		0.30					
2		0.80					
3		1.50					
4		2.40					
5		3.50					
6		4.80					
7		6.30					
8		8.00					
9		9.90					
10		12.00					

Q (quantity) – keeps increase by 1 as the firm increases production

FC (fixed cost) – remains the same no matter the Q produced because that's the definition of fixed cost

VC (variable cost) – increases as Q increases; more importantly, it goes up *at an ever-increasing rate* for each unit increase in Q (this is a manifestation of the **law of diminishing marginal product**[2])

TC (total cost) – FC + VC, so it continually goes up with Q

AFC (average fixed cost) – FC / Q; since FC is fixed, AFC keeps falling with Q; in fact, it will asymptote toward 0 ("asymptote toward 0" is a mathematical term meaning it will get closer and closer and closer to 0 without ever hitting 0)

AVC (average variable cost) – VC / Q; keeps increasing since VC increases by more for each successive unit increase of Q

---

[1] As with the previous set of notes, a full solution to Table 4 is provided at the end of this document but the notes following Table 4 continue as if Table 4 has been correctly filled out by the student.

[2] In the week 12 notes, each additional worker produced less and less additional corn output. Here, using the logic of the law of diminishing marginal product, and since output goes up by 1 every time, it would require more and more additional inputs to get that same unit increase in output. Those "more and more additional inputs" mean more and more additional costs, so VC keeps increasing by ever-increasing amounts.

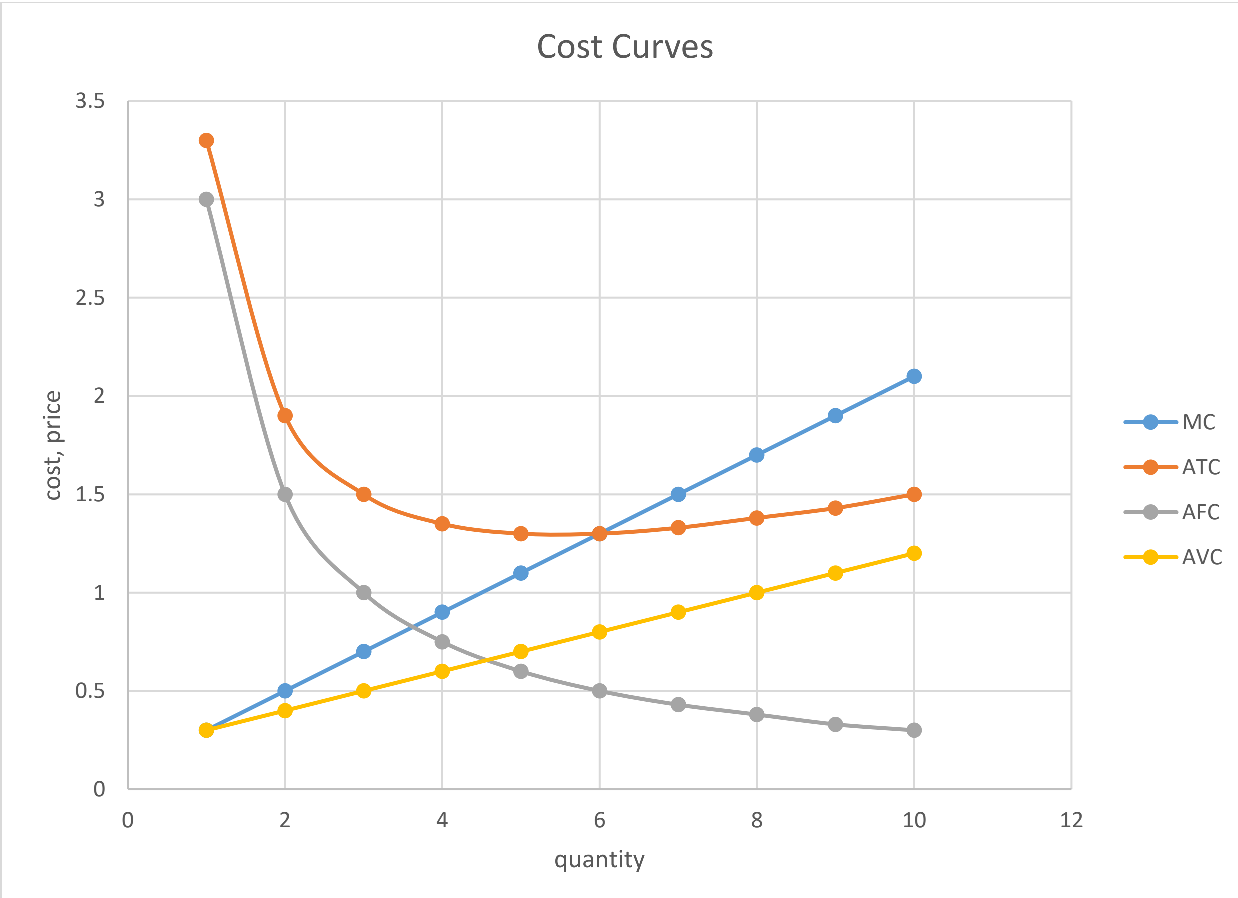
ATC (average total cost) – TC / Q (or AFC + AVC); notice that this falls at first (due to plummeting AFC) but then starts to rise at higher Q where the fall in AFC for each additional unit of output is more than offset by rise in AVC; parabola-shaped due to the initial fall, then rise

MC (marginal cost) – ΔTC; keeps increasing, also due to VC increasing by more for each increase in Q

Graphically, the results in Table 4 would generically look like this…

Note that MC passes through the minimum of ATC. <u>That always is the case if you draw these graphs properly, and hence it is a necessary requirement of drawing them correctly</u>. Why does that happen? Remember what the terms means – MC is the additional cost of the last unit of output, and ATC is the average total cost of all output to that point. If MC > ATC (meaning that the cost of the last unit was higher than the average cost of all units), then it will pull serve to pull ATC up. Likewise, if MC < ATC, it will pull ATC down. A quick numeric example can help with understanding. Say the costs of three previous units were \$4, \$5, and \$6, respectively, for an ATC of \$5. If the next unit costs \$7 (that \$7 is the MC of the next unit), that will increase ATC since MC > ATC. In fact, the ATC of those 4 units with costs of \$4, \$5, \$6, and \$7 is \$5.50, an increase over the previous ATC of 3 units of \$5.

More precisely, if graphed in Excel, we get this…



Take away messages from cost curves and Table 4

- ATC is a parabola (U-shaped)
- MC is always increasing (due to law of diminishing marginal product)
- MC goes through minimum of ATC
- Always remember that implicit costs are already included

What you should realize about increasing MC is that it comes about for reasons of specialization and crowding. Each additional unit of output will cost more to make because the FOP you have to hire to make the unit are 1) not as productive as the previous hire and 2) not able to use the best equipment (i.e. the other types of FOPs) as previous hires.

So we know from the week 12 notes that a producer will hire FOP until the VMP for that last FOP exactly equals its MC. When we switch over to viewing output as increasing by 1 (instead of input), we know what the cost curves look like for a producer and why VC and MC keep increasing. So how does he decide how much to produce? Well it turns out that will depend on how the companies are structured in the industry in which this producer resides. In economics parlance, it depends on the *industrial* *organization* around the company. Industrial organization can be thought of as a continuum, with different assumptions and therefore different conclusions about production and profit depending on where on the continuum your industry falls. We will go into more detail on this over the next few sets of notes (especially regarding what distinguishes the different industrial organizations and why they exist), but for now the following figure will suffice:

Perfect competition *Monopolistic competition* *Oligopoly* *Monopoly*

→→→→→→→→→→→→ Uniqueness of produced good ↑ →→→→→→→→→→→→→→

→→→→→→→→→→→→ Control of price ↑ →→→→→→→→→→→→→→

The uniqueness of your produced good increases as you move to the right on the continuum, and hence the ability to control the price increases.

Let's solve the issue of "How much should he produce?" assuming we are on the left hand side of that continuum and our producer is in a market characterized by perfect competition.

<u>Perfectly competitive market</u> characteristics/assumptions (these were already addressed in the week 10 notes, so this should be a refresher)

- Buyers and sellers are so numerous that nobody can affect market price
- Can sell as many units of output as you like
- Goods offered are largely the same (no difference between the good sold in my store, down the road, or across the state)
- Market price of the good is given (firms in competitive markets are *price takers*)
- Firms can freely enter or exit the market whenever they want

Most markets in the US can be considered close enough to "perfectly competitive" that the basic assumptions above hold in a lot of circumstances. Also notice how these assumptions link up with the figure above. Since perfect competition is on the far left of the continuum of industrial organization, the producer's good is not unique and he has no control over price. That's the same idea as saying the "goods offered are largely the same" and he's a "price taker."

So the producer can sell as many units as they want and the market price is given…

Say corn sells for $5. If the producer sells 1 unit, how much money does he make? (Answer: Clearly $5)

If the producer sells 2 units, how much money does he make? (Answer: $10)

That leads us to Table 5. Fill it out below on your own or consult the solution at the end of this set of notes. Assume the price of corn is $5.

Table 5

Corn Produced (Q)	Total Revenue (TR)	Marginal Revenue (MR)
0		n/a
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

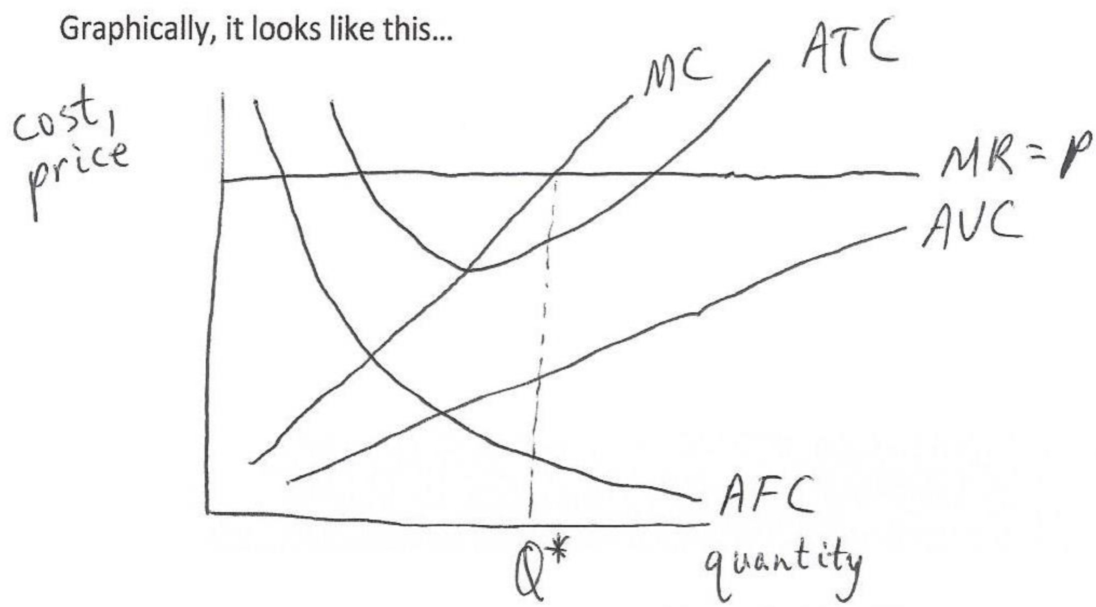
Notice that MR never changes. Each additional corn produced makes $5 for the producer. This is the essence of the assumptions above regarding being a price taker and being able to sell as many units as you want.

So we know (from Tables 4 and 5) that MC continually increases and, for firms in perfectly competitive markets, MR is always the same (it is the price the produced good sells for). BUT HOW MUCH DOES HE CHOOSE TO PRODUCE?

Let's break the problem down a bit. We know (as a general business maxim) that the producer wants to maximize profit. *He will decide on each additional unit of production based on whether or not it increase profit*. Remember principle #4? The producer evaluates ***the next unit*** **(the marginal unit) at every possible level of production**. If profit would go up by producing that next unit, he chooses to produce it and then re-evaluates at that next marginal unit. If profit would go up by producing another marginal unit, he produces it and once again re-evaluate the next possible unit. If at any point, if profit would go down, he does *not* produce that next unit. As long as the revenue of the next unit is bigger than the cost of making the next unit, the producer makes it and then re-evaluates. In other words, produce the next unit if MR > MC.

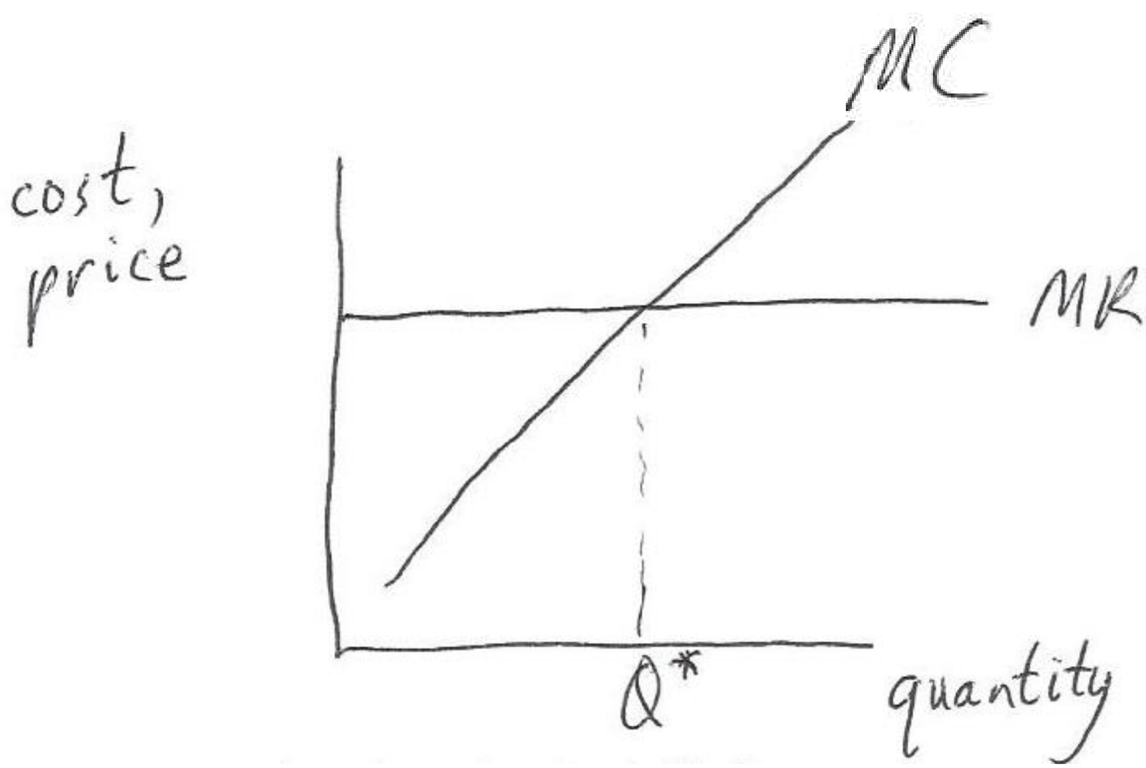
Since MR is fixed and MC rises with each unit of production, the producer will ultimately produce up to the point as which MR = MC. This is the same thing we showed in the week 12 notes! Once he hits that point, *any further production would be detrimental* (would decrease profit).

Graphically, it looks like this…



The amount the producer in a perfectly competitive market makes is Q*, the quantity where MR = MC (graphically, where MR intersects MC).

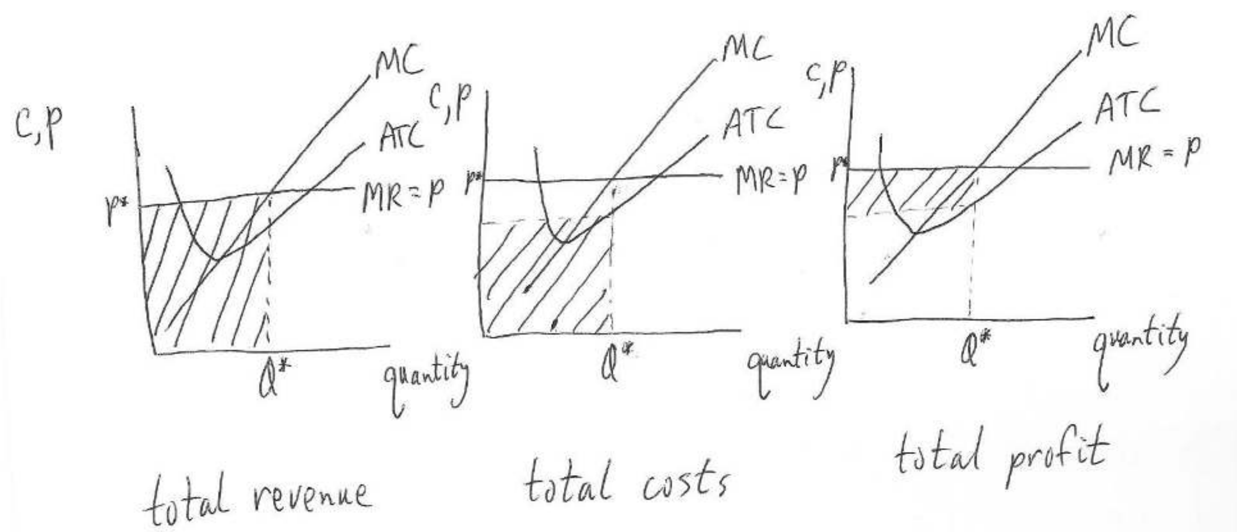
Focus just on the MR and MC lines.



Question: What does that look like?

Answer: It looks like a supply (MC) and demand (MR) curve, except demand is perfectly elastic. That makes sense in light of what the assumptions of perfectly competitive markets are. Prices are given and demand is insatiable (sellers can sell as much as they make). That's the exact feature of a perfectly elastic demand curve!

How much profit does the firm make? This is where calculating *average* costs is important. First of all, the total revenue made by the firm is easy. It is simply Q* x P*. Graphically, it is the area covered by the horizontal axis from the origin over to Q* and the vertical axis from the origin up to P*. But how much is the cost of producing Q*? One way to find it is by figuring out the cost of each unit and adding them all together. *The easier way would be to simply realize that ATC (at Q*) x Q* is the total cost for producing Q* units.* Graphically, it is the area covered by the horizontal axis from origin over to Q* and the vertical axis from the origin up to the ATC curve at Q*. Then the profit is the difference between them. The revenue, cost, and profit boxes are shown graphically below.



So as long as the intersection of MR and MC is above ATC, the firm makes a profit. But what happens over time? If there are profits to be made in this industry, what happens? **Clearly, others will flock to it because they also want to realize these profits** (think gold rushes). So they do. And in the long run[3] those profits eventually become 0. As more and more firms enter this market, the profit box gets squeezed from below and above until it disappears.

From below: As the demand for the FOP involved in making the good goes up (because more firms want to enter the market, there is greater need/demand for the things – labor, capital, land, raw materials – that are needed to produce the final good), the price of those FOP goes up.[4] The price of the FOP is the

[3] For our purposes, let's define the "long run" very simply – it is the amount of time it takes for firms to enter or exit this market.

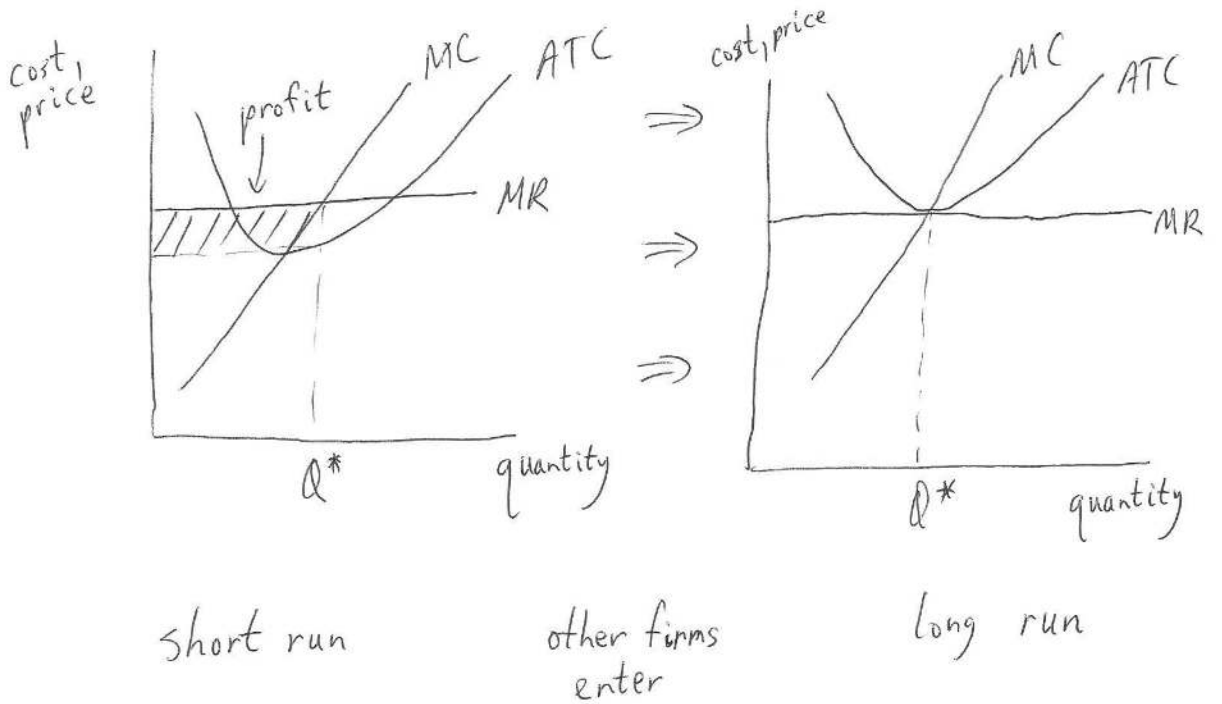
[4] Remember one of the "demand shifters" is a change in the number of buyers. The new firms entering this market are buyers of the FOP needed to make the good/service they produce, so in the market for those FOP, we see the supply curve shift right and hence the price increase.

same as the cost to the producer! So producer costs go up, ATC goes up, MC goes up, and ultimately the original firm in this profitable market makes less output (Q** < Q* below) and 0 profit.

From above: More firms are entering the market (supply shifter), so supply of the final produced good is increasing. When supply increases, price decreases. So the MR = P line falls.

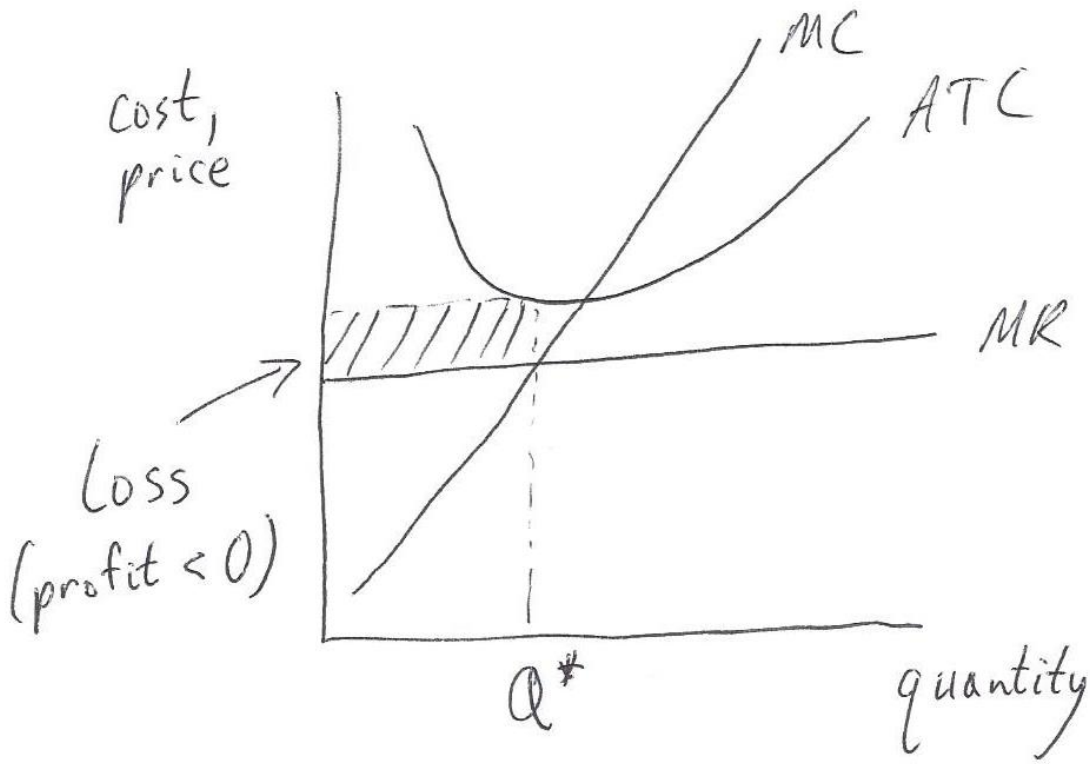
ON YOUR OWN: Show each of those "squeeze" explanations in graphical form.

The short and long run graphs of perfect competition (with positive profit in short run) are shown below.



But if the long-run prospect for any firm in competitive markets is to make 0 profit, why do it? Remember we are talking about economic profits here. That is, the "cost" side already includes fair compensation for the producer for both his time and money. Making 0 economic profit means positive accounting profit. This was addressed in the week 12 notes.

That was what happened when profits in the short-run were positive. What if business is bad? What if profits would be negative for a firm if they followed the MR = MC rule? Should they still produce?



Question: Why should the producer even make Q* in the depiction above? Why not just shut down and produce nothing if you know profit will be negative?

Answer: The producer needs to consider the two *types* of cost separately. Remember that he pays fixed costs regardless of whether or not he produces anything. If he makes 0 units, the fixed costs are still there. If he makes 100 units, the fixed costs are still there. If he makes 10,000 units, the fixed costs are still there. **Since the fixed costs will be paid regardless, the producer has to decide whether to shutdown (Q* = 0) or produce such that MR = MC even if he will experience negative profit by evaluating whether the revenue from the units produced is greater than the variable costs for producing them.** As an example, say FC = 100. By shutting down, your profit is -100. If you can produce 10 units and sell each for $3, and making those 10 units only costs $20 total (so AVC is $2), then you only lose $90 by producing 10 units. Producing something is better than shutting down because you have less negative (i.e. "higher") profits.

So if the Q* such that MR = MC is above ATC, you get positive profit (in short-run anyway). If Q* such that MR = MC is below ATC, you will have negative profit (again, short-run). If the Q* such that MR = MC is <u>below AVC</u>, just bite the bullet, shut it down, lose the fixed cost, and go screaming toward the exit doors of the industry. But if Q* such that MR = MC is below ATC and above AVC, **you will choose to**

produce at a loss because you will at least make up some of the fixed cost. In the long-run, you may still exit since $\pi < 0$.[5] Those four situations are shown graphically on page 11.

If there are short-run negative profits, some firms will exit the market over time. This causes the opposite of what was described on pages 7 and 8. It decreases demand for FOP, lowering their price and hence decreasing costs for the remaining firms. In addition, the decrease in supply of the produced good will increase its price. Eventually, the firms that stay reach $\pi = 0$ in the long run.

So the producer problem should get a slight update. Producers produce such that MR = MC *provided they are above AVC at that Q**. Unless otherwise noted, always assume they are above AVC and just shorten it to what we said before: **produce Q* such that MR = MC**.

Practice problem:

Complete the table depicting costs for a firm and answer the question that follow.

Table 6

Pens produced	Total cost (TC)	Marginal cost (MC)
0	5.00	
1	5.50	
2	6.50	
3	8.00	
4	10.00	
5	12.50	
6	15.50	
7	19.00	
8	23.00	
9	27.50	
10	32.50	

What are fixed costs here?

If we have a perfectly competitive market and the price of pens is $4, how many pens will the firm with costs depicted above produce?

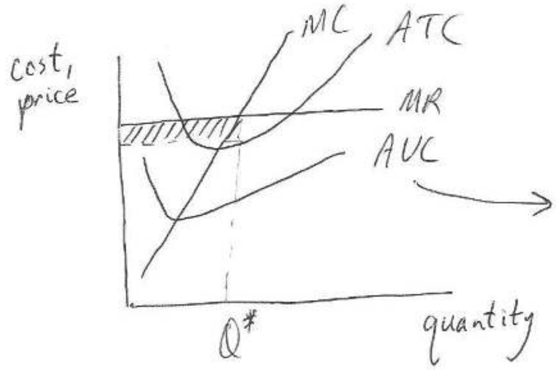
How much revenue does the firm make?

How much π does the firm make?

Will other firms enter or exit this market over time?

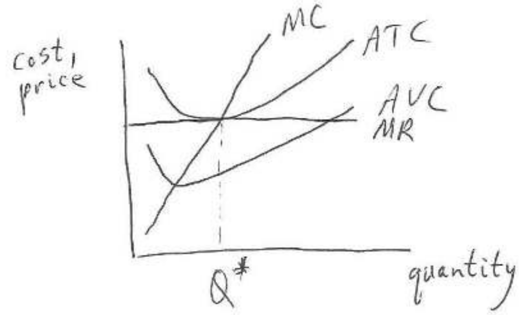
What will π be in the long-run?

[5] Economists often use π to represent profit. I will do that from now on to get you used to the notation.

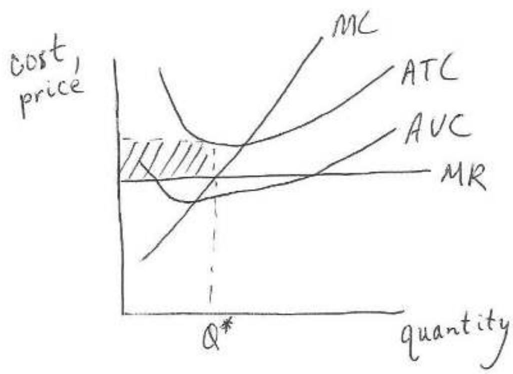


produce Q^*
make positive profit (box)

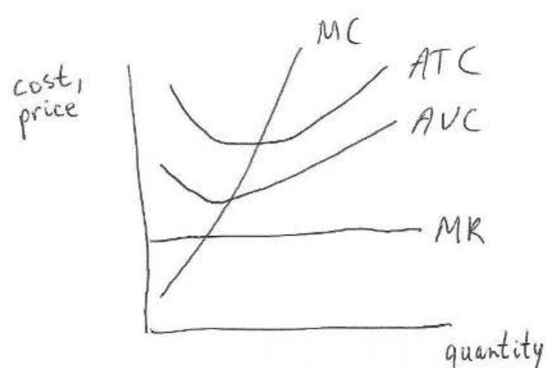
Note that AVC initially falls. The book has an argument for it. Don't worry about it. If you assume it always goes up, that's fine.



produce Q^*
profit = 0



produce Q^*
profit is negative (box)



shut down ($Q^* = 0$)
Lose fixed cost

SUGGESTED PROBLEMS – pg 222, #7, 10, 11, and 12

Answers:

Table 4

Q	FC	VC	TC	AFC	AVC	ATC	MC
0	3	0	3	n/a	n/a	n/a	n/a
1	3	0.30	3.30	3.00	0.30	3.30	0.30
2	3	0.80	3.80	1.50	0.40	1.90	0.50
3	3	1.50	4.50	1.00	0.50	1.50	0.70
4	3	2.40	5.40	0.75	0.60	1.35	0.90
5	3	3.50	6.50	0.60	0.70	1.30	1.10
6	3	4.80	7.80	0.50	0.80	1.30	1.30
7	3	6.30	9.30	0.43	0.90	1.33	1.50
8	3	8.00	11.00	0.38	1.00	1.38	1.70
9	3	9.90	12.90	0.33	1.10	1.43	1.90
10	3	12.00	15.00	0.30	1.20	1.50	2.10

Table 5

Corn Produced (Q)	Total Revenue (TR)	Marginal Revenue (MR)
0	0	n/a
1	5	5
2	10	5
3	15	5
4	20	5
5	25	5
6	30	5
7	35	5
8	40	5
9	45	5
10	50	5

Table 6

Pens produced	Total cost (TC)	Marginal cost (MC)
0	5.00	n/a
1	5.50	0.50
2	6.50	1.00
3	8.00	1.50
4	10.00	2.00
5	12.50	2.50
6	15.50	3.00
7	19.00	3.50
8	23.00	4.00
9	27.50	4.50
10	32.50	5.00

Fixed costs can be found by realizing that variable costs at 0 production must be 0, so the only total costs there must be fixed costs. Therefore, FC = 5.

He will produce Q* such that MR = MC. Since price is $4 in this competitive market, MR = 4. MC = 4 when **Q* = 8**.

Revenue = P* x Q* = $4 x 8 = $32

π = Revenue – Cost = $32 – $23 = $9   ($23 is simply taken from the table. If is TC at Q* = 8.)

Other firms will enter since π is positive.

In the long-run, π will be 0.