

Directions: The homework will be collected in a box before the lecture. Please place your name, TA name and section number on top of the homework (legibly). Make sure you write your name as it appears on your ID so that you can receive the correct grade. Late homework will not be accepted so make plans ahead of time. Please show your work. Good luck!

Please realize that you are essentially creating “your brand” when you submit this homework. Do you want your homework to convey that you are competent, careful, and professional? Or, do you want to convey the image that you are careless, sloppy, and less than professional? For the rest of your life you will be creating your brand: please think about what you are saying about yourself when you do any work for someone else!

Consumer Theory – Deriving a Demand Curve

- 1) The goal of this problem is to highlight the connection between Consumer Theory topics like utility and budget lines, and our understanding of downward sloping demand curves.

Joe is a student who can spend his income on either Chipotle burritos or Noodles & Co. salads. These two meals are substitutes for each other, but Joe’s optimal consumption includes a mix of burritos and salads. Joe’s budget constraint is given by the formula:

$$Y = P_B B + P_S S$$

Where Y is the amount of income Joe has, P_B is the price of a burrito, B is the number of burritos he eats, P_S is price of a salad, and S is the number of salads he eats.

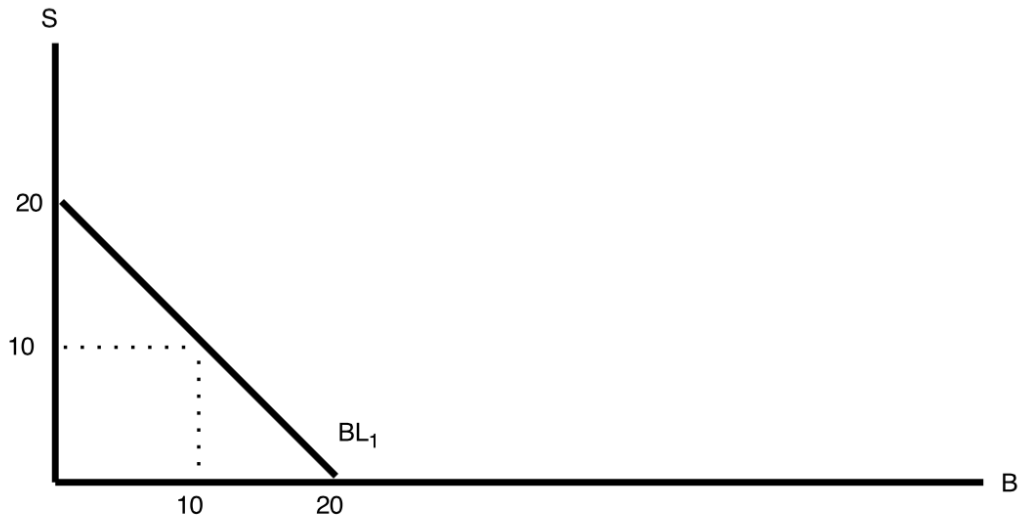
- a. Initially, Joe has $Y = \$100$, and the prices of burritos and salads are each $P_B = P_S = \$5$. Graph Joe’s budget constraint, with burritos on the horizontal axis and salads on the vertical axis. We will be adding more lines to this graph, so be sure to leave lots of extra space on the horizontal axis!

After plugging in the prices and income, the budget line can be rewritten as

$$S = -B + 20$$

And the graph is drawn in the answer to part (b) below.

- b. At this initial set of prices, Joe’s optimal consumption bundle is $(B = 10, S = 10)$. Mark this point on your graph. (This point should lay directly on Joe’s budget line, so double check your numbers.)



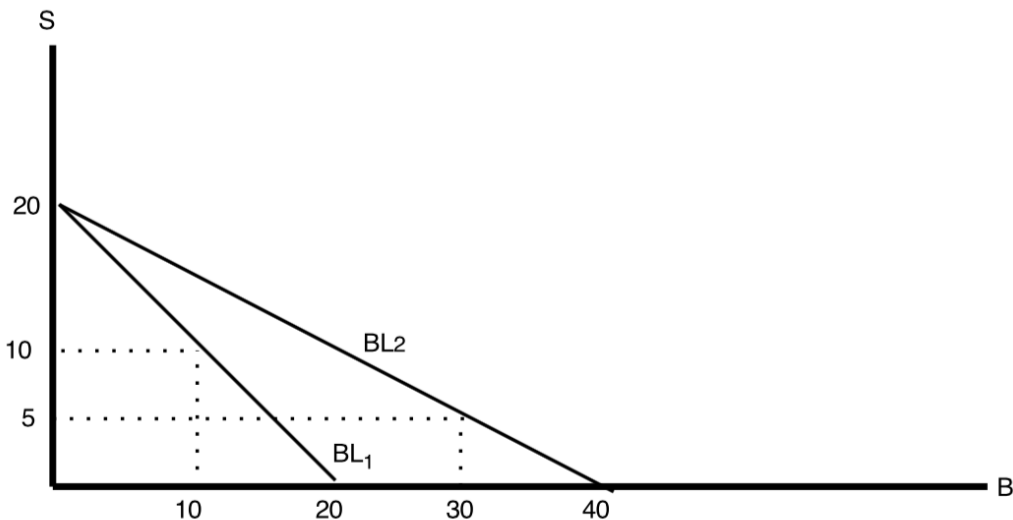
- c. Chipotle now announces a special burrito sale, where the price of burritos will now be $P_B = \$2.5$. What is Joe's new budget constraint? Add this new line to your graph from part (a).

With the new prices, the budget constraint is:

$$100 = 2.5B + 5S$$

$$S = -.5B + 20$$

- d. With this burrito sale, Joe's new optimal consumption bundle is $(B = 30, S = 5)$. Add this point to your graph as well.



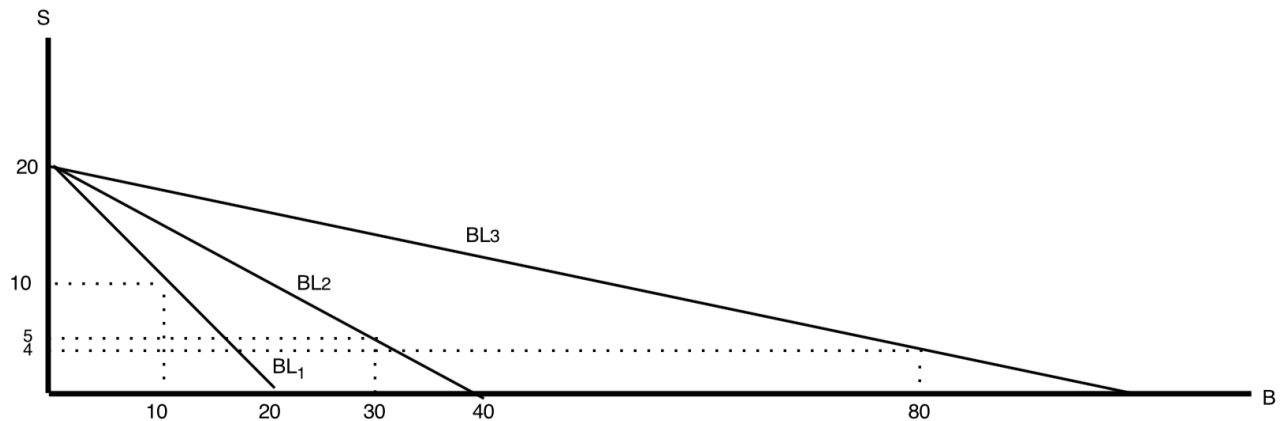
- e. Finally, Chipotle realizes they made a huge mistake with their burrito sale, and now have to go out of business. But before they do, they have one last closeout sale, lowering the

price of burritos to $P_B = \$1$. What is Joe's budget constraint now? Add this new line to your graph from part (a).

$$100 = 1B + 5S$$

$$S = -.2B + 20$$

- f. With this super low closeout sale price, Joe's optimal consumption bundle is $(B = 80, S = 4)$. Add this final point to your graph.

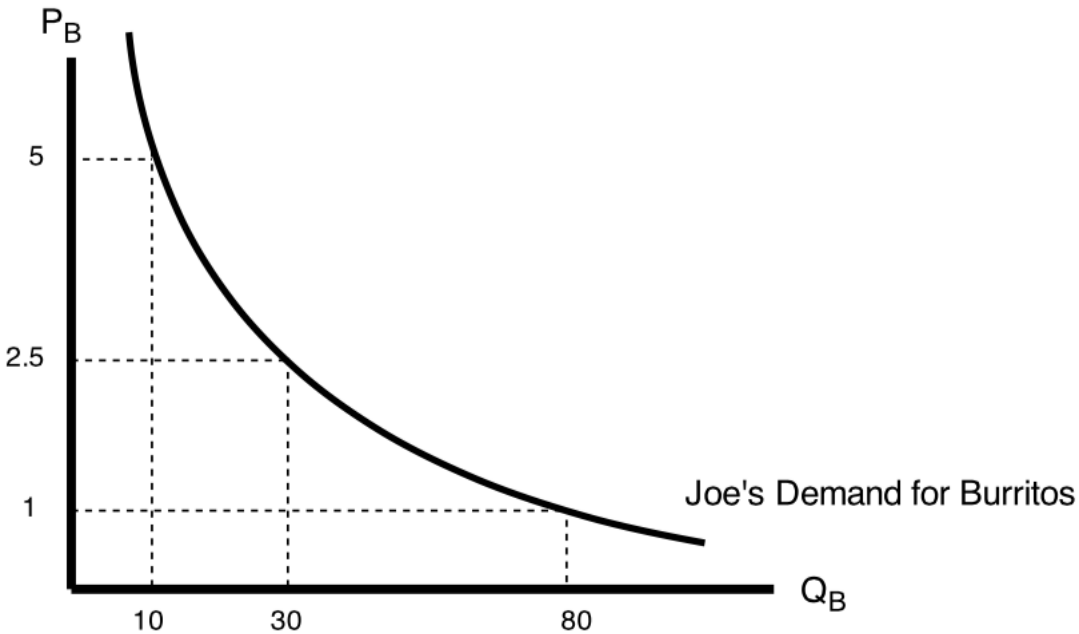


- g. Now we can go back to our graph and see the quantity of burritos Joe will buy when the price, P_B , is at three different levels. To make a new graph, showing Joe's Demand Curve for burritos, we can use these three different points. Think carefully about which quantities and prices should be on each axis, and then plot Joe's three optimal burrito consumption points on the graph. Add a line that goes through these points (it may be curved), and it should trace out a possible demand curve!

The demand curve for burritos describes the relationship between the price of burritos (P_B) and the quantity of burritos Joe buys, (B , relabeled as Q_B). The three points (Q_B, P_B) that we have learned are on the demand curve are:

(10, \$5)
(30, \$2.5)
(80, \$1)

We can draw a demand curve by plotting these with P_B on the vertical axis, and Q_B on the horizontal axis.



Production and Costs

- 2) Sarah owns a custom t-shirt business in Madison. The quantity of t-shirts that her company can produce (q) depends on the amount of capital (K) and labor (L) that she employs. The units of capital represent the number of screen-printing machines her business owns. The units of labor represent the number of employees she hires. Her costs of employing the capital and labor are given in dollars. The following table describes the production and costs for given levels of K and L

K	L	q	FC	VC	TC	AFC	AVC	ATC	MC	MPL
2	0	0			50	-	-	-	-	-
2		2							\$5/unit of output	2 units of output/unit of labor
2	2	5								
2		10			80					
2	4									
2	5	25								5
2		30		70						
2	9	32								

- How much does each screen-printing machine (unit of K) cost?
In the first row, Sarah is employing zero labor, so her only costs are for capital. With 2 units of capital, her total costs are 50. So each unit of K must cost \$25.
- How much does each unit of labor cost? You can assume that this wage is constant.

Here you want to use the two pieces of information in 2 right-most columns, in the second row. The MPL column tells us that when we move to this row, each additional unit of L generates 2 units of output. Moving from row 1 to row 2, we've gone from output of $q = 0$ to $q = 2$. So Sarah must have hired one unit of labor, $L = 1$.

Now the MC column tells us that when we moved to this row and produced the 2 additional units, Sarah's costs were \$5 per unit. So total costs must have increased by $\$5 \times 2 = \10 . Sarah did not employ any additional capital, so this \$10 increase in total costs must have come from the cost of hiring the one unit of labor. So the cost per unit of labor (or wage) = \$10.

- c. Fill out all the other missing pieces of information in the table. Make sure that you answers are consistent with the values that have been provided.

K	L	q	FC	VC	TC	AFC	AVC	ATC	MC	MPL
2	0	0	50	0	50	-	-	-	-	-
2	1	2	50	10	60	25	5	30	\$5/unit of output	2 units of output/unit of labor
2	2	5	50	20	70	10	4	14	3.333333333	3
2	3	10	50	30	80	5	3	8	2	5
2	4	20	50	40	90	2.5	2	4.5	1	10
2	5	25	50	50	100	2	2	4	2	5
2	7	30	50	70	120	1.666666667	2.333333333	4	4	2.5
2	9	32	50	90	140	1.5625	2.8125	4.375	10	1

- d. As Sarah hires more workers, does the marginal product of those workers (the MPL) increase? Does marginal product of labor begin to diminish at some point?

As Sarah hires more workers, the MPL initially increases, until it reaches $MPL = 10$ for the 4th worker. Then the added gains per worker begin to diminish.

- e. Can we tell whether Sarah's business will be operating in the short run? What about in the long run? What piece of information do we still need to learn to know for sure?

So far we have learned lots about Sarah's costs of operating, but in order to know whether she will be able to stay in business, we need to know what price she can sell shirts for. In order to operate in the short run, the price of a t-shirt needs to be above the minimum point of AVC, which occurs where $AVC = MC$. In the long run, she needs to be able to cover her fixed costs as well, so the price needs to be above the minimum of ATC, which occurs where $ATC = MC$.

- f. Let's say that the price of t-shirts is \$2. How many t-shirts would Sarah's business produce? What would be her profit or loss?

Sarah will want to choose to produce the quantity q at which $P = MC$. On the table, note that there are 2 quantities ($q = 10$ and $q = 25$) where $MC = 2$. If she chose $q = 10$, then she would still be able to hire one more laborer, and produce 10 additional units at $MC = 1$. This would definitely be profitable for her. At $q = 25$ however, the marginal cost of

any additional units is $MC = 4$, which is above the price she can sell them for, and so not profitable.

So Sarah will choose to produce $q = 25$ shirts. Her profit is given by total revenue minus total costs:

$$\begin{aligned}\text{Profit} &= P \cdot q - TC \\ &= 2 \cdot 25 - 100 \\ &= -50\end{aligned}$$

Sarah has negative profits at this quantity level, particularly because she is not making enough revenue to cover her fixed costs.

- g. At what Shutdown Price would Sarah stop producing any t-shirts at all?
The Shutdown price is the price at the minimum of AVC. If the price is below the minimum of AVC, then Sarah cannot even cover her variable costs, and it does not make any sense to produce any shirts. Here the shutdown price is $P = \min(AVC) = 2$.
- h. What is the Breakeven Price for Sarah? This is the price at which she makes exactly zero profits in the long run.
In order to break even, Sarah needs to earn a price equal to the minimum of ATC. If price is below ATC but above AVC, then Sarah is earning more revenue than she is spending on variable costs like labor, but not enough to cover her long-run fixed costs like capital. So to stay in business in the long run, Sarah needs to earn at least $P = \min(ATC) = 4$.

Perfect Competition

- 3) Madison is a town with many, many coffee shops. These shops are mostly the same size, and they produce similar food and drinks using similar equipment. A group of economics students runs one of the shops, called Econocoffee. Like all the shops in Madison, their total and marginal cost curves are given by:

$$TC = .1q^2 + 10$$

$$MC = .2q$$

Where q is the number of coffees sold by Econocoffee. Because there are so many coffee shops, Econocoffee must take the equilibrium price as given when choosing how much to produce.

- a. Which part of Total Costs are Fixed Costs? Which part represents Variable Costs? Write down the equations for Econocoffee's Average Total Cost (ATC) and Average Variable Cost (AVC).

Total costs, TC, can be broken down into fixed costs, which must be paid regardless of the quantity produced, and variable costs, which depend on the quantity produced. Total costs are the sum of these:

$$TC = FC + VC$$

To solve for what FC are, set the quantity produced equal to zero ($q = 0$), and see what costs Econocoffee still has to pay:

$$FC = .1(0)^2 + 10$$

$$FC = 10$$

And variable costs are everything that is left over:

$$VC = TC - FC$$

$$VC = .1q^2 + 10 - 10$$

$$VC = .1q^2$$

To get ATC and AVC, just divide what you gave for TC and VC respectively by the quantity produced q :

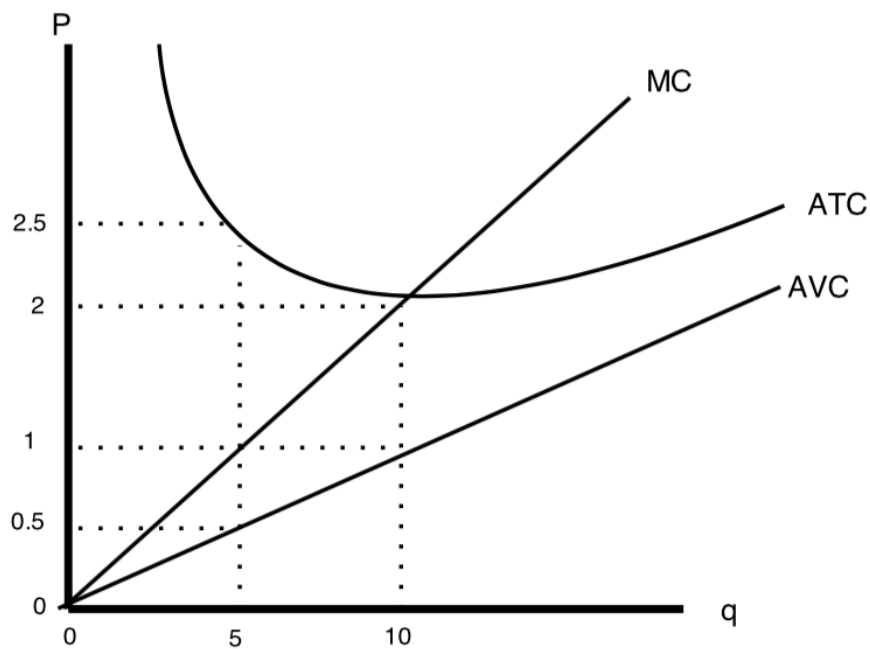
$$ATC = TC/q$$

$$ATC = .1q + 10/q$$

$$AVC = VC/q$$

$$AVC = .1q$$

- b. Graph Econocoffee's ATC, AVC, and MC curves on the same graph. A good approach here is to try plugging in a few points for each curve.



- c. What are the Breakeven and Shutdown prices of coffee for Econocoffee? Mark these points on your graph.

Breakeven:

$$ATC = MC$$

$$.1q + 10/q = .2q$$

$$10/q = .1q$$

$$100 = q^2$$

$$q = 10$$

plugging back into MC:

$$P_{\text{BreakEven}} = .2(10) = \$2$$

Shutdown:

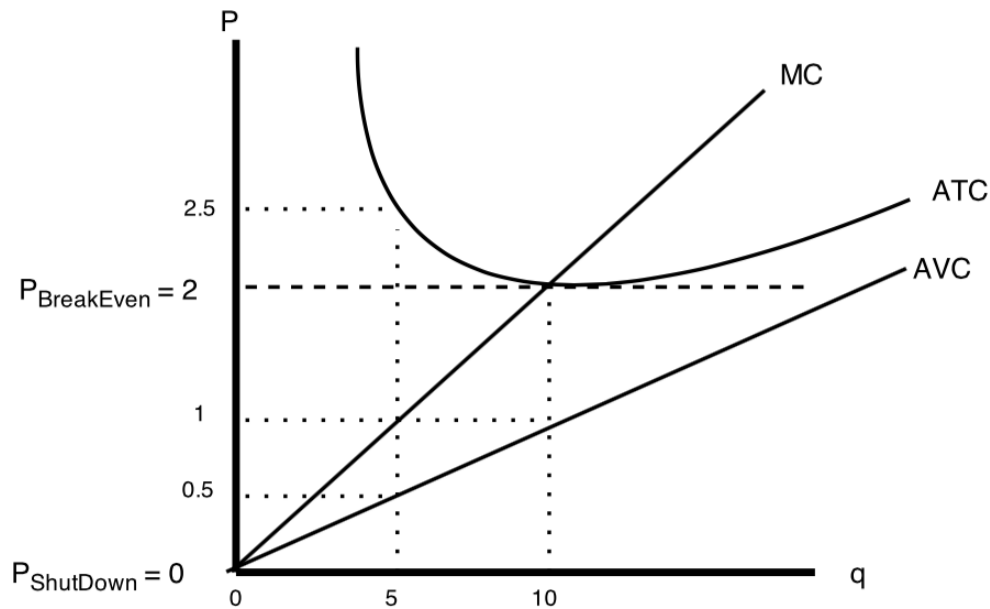
$$AVC = MC$$

$$.1q = .2q$$

$$0 = .1q$$

$$q = 0$$

$$P_{\text{Shutdown}} = .2(0) = \$0$$



- d. Econocoffee is not the only shop in town. Assume that all of the coffee shops in town have identical costs and identical coffees, and that the market is perfectly competitive. Given this information, what is the long run equilibrium price, and how much coffee does each firm produce?

In the long-run equilibrium, firms will be making zero long-run profits, otherwise some new firms would want to enter, or existing firms would want to exit. This means that the equilibrium price must be:

$$P_e = P_{\text{BreakEven}} = \$2$$

And each firm is setting $MC = P$

$$.2q = 2$$

$q = 10$ units being produced by each firm.

Suppose we know that the demand curve for coffee in Madison is given by:

$$\text{Demand: } P = 10 - .05Q$$

Where Q is the number of total coffees purchased from all shops.

- e. Given this new information about demand, and based on what we calculated in part (d), how many total coffees will be sold in Madison? How many coffee shops are there in business?

We can plug the equilibrium price $P = 2$ into the demand curve:

$$2 = 10 - .05Q$$

$$.05Q = 8$$

$$Q = 160 \text{ coffees.}$$

Now we also know that each firm chooses to produce $q = 10$ coffees when the price is 2, so we can rewrite the total number of coffees as

$$Q = N * q$$

Where N is the number of coffee shops in the market.

$$160 = N * 10$$

$$N = 16 \text{ coffee shops.}$$

Now there is a change in the market, as a huge new apartment complex called the Hub opens on State Street. This brings an influx of under-caffeinated consumers into the market, and the demand for coffee increases:

$$\text{New Demand: } P = 12 - .05Q$$

- f. In the short run, all coffee shops cannot adjust their fixed costs, and new shops cannot open. The only things that businesses can adjust are P and q . What will be the new short run equilibrium price for a coffee? What is the total quantity sold, and how much is sold by each shop?

In equilibrium, firms will always be setting $P = MC$. The new demand curve gives us an equation for P , and our cost equations tell us MC .

$$P = MC$$

$$12 - .05Q = .2q$$

$$12 - .05(N * q) = .2q$$

In the short-run, the number of firms is fixed at $N = 16$:

$$12 - .05(16q) = .2q$$

$$12 - .8q = .2q$$

$$12 = q$$

so each of the 16 coffee shops is now producing 12 units, and

$$P = MC = .2q$$

$$P = .2(12) = \$2.4$$

Price has increased to \$2.4. The total quantity sold is now:

$$Q = N * q$$

$$Q = 16 * 12$$

$$Q = 192$$

- g. At the new short run equilibrium prices and quantities, calculate the profit being earned by Econocoffee.

Econocoffee (and all the other identical coffee shops) each earns a profit that is total revenue – total costs. We can write this as:

$$\begin{aligned}\text{Profit} &= \text{TR} - \text{TC} \\ &= P \cdot q - \text{ATC} \cdot q \\ &= (P - \text{ATC}) \cdot q \\ &= (2.4 - .1(12)^2 - 10) \cdot 12 \\ &= \$4.4\end{aligned}$$

- h. In the long run, new businesses can firms can enter and old businesses can exit. Given the profits calculated in part (g), will new coffee shops want to enter in the long run? Or will existing shops want to exit?

With the new increased demand, all the existing coffee shops are making positive profits, so they will not want to exit the market. Other new coffee shops will want to enter the market however, to try to earn their own positive profits.

- i. Calculate the long run number of coffee shops that will exist in Madison now that the new apartment complex has opened. What happens to the profit made by firms once we are back in long run equilibrium?

New coffee shops will continue entering the market until profits are zero. Profits reach zero once the price falls back down to $P_{\text{BreakEven}} = 2$.

As we calculated before, when $P = 2$, each coffee shop will only want to produce $q = 10$ units. To figure out how much total coffee will be demanded, we can plug this new equilibrium price back into the new demand curve:

$$\begin{aligned}2 &= 12 - .05Q \\ .05Q &= 10 \\ Q &= 200\end{aligned}$$

So in order for 200 units of coffee to be produced, when each shop is making $q = 10$ units:

$$\begin{aligned}Q &= N \cdot q \\ 200 &= 10N \\ N &= 20\end{aligned}$$

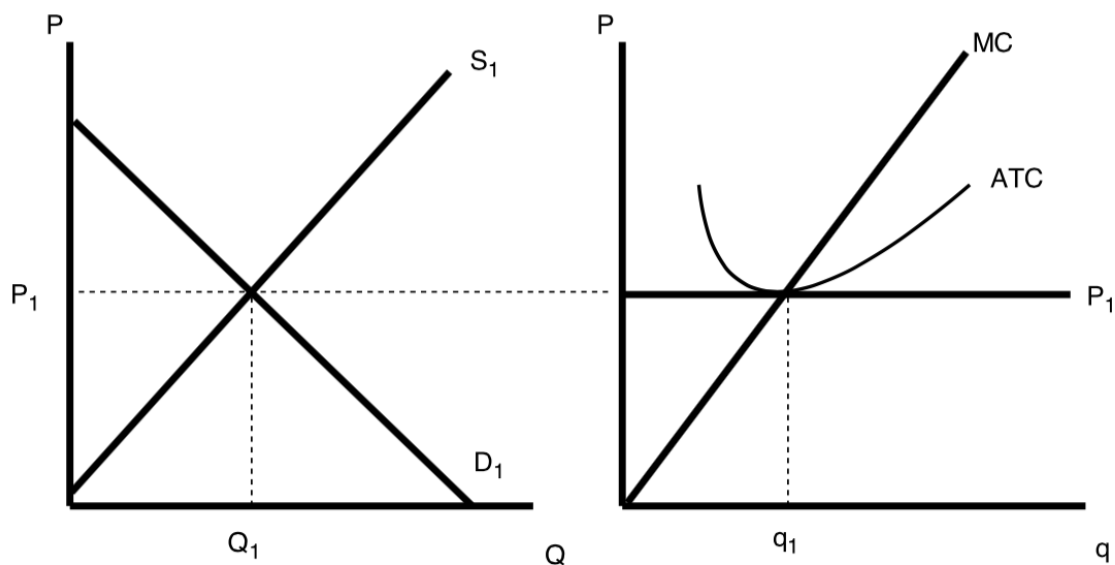
Madison will have 20 coffee shops in the new long-run equilibrium. Note that because $P = 2 = P_{\text{BreakEven}}$, All the shops are now earning zero profits again.

Graphing Perfect Competition

- 4) For this problem, think about a perfectly competitive market for organic vegetables. Many small, identical farms supply the organic vegetables.

The aggregate demand for organic foods in the whole country is given by a standard downward sloping demand curve. Each farm takes the equilibrium market price as given, and decides how much to produce.

We want to graph what supply, demand, and costs look like for each individual firm, and for the market as a whole. Our initial long-run equilibrium, say in the mid 2000's, is graphed below:



The graph on the left shows market supply and market demand. The graph on the right shows the prices and costs faced by the individual farms in this market.

- a. First, redraw the two graphs above, leaving room below for two additional pairs of graphs. Make sure to mark the price (P_1) and the market (Q_1) and firm (q_1) quantities. Are the farms making any profits in this equilibrium?

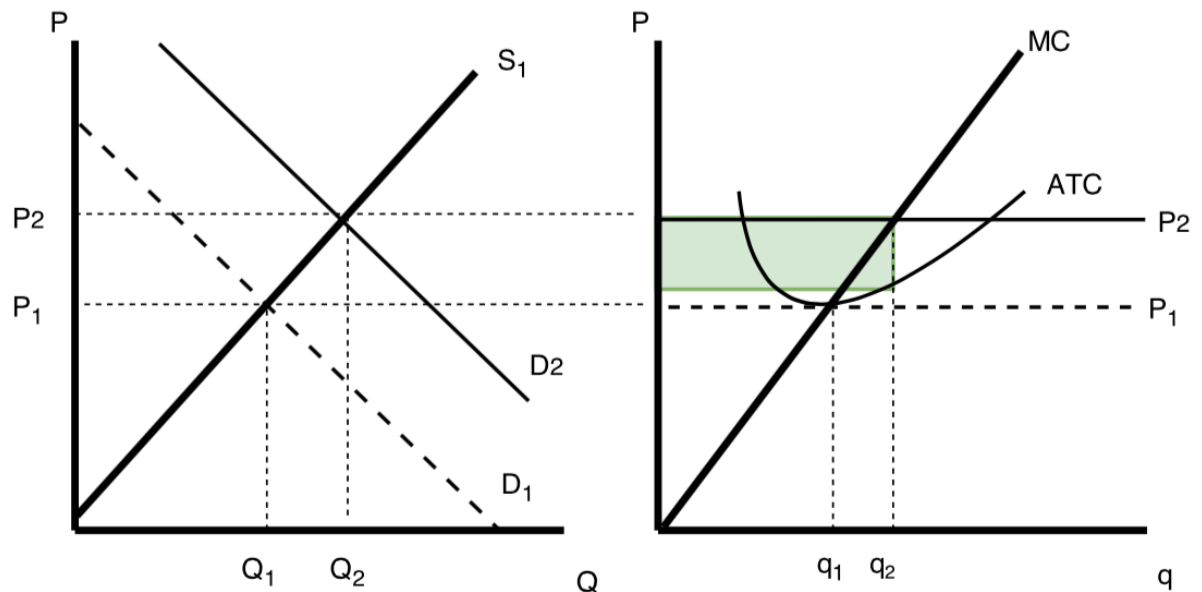
The farms are making zero profits, since the price they receive per unit is exactly equal to their average total costs per unit, $P_1 = ATC$.

During the last few years, a lot of people have gotten very interested in how their food is produced, and want to consume more certified organic foods.

- b. In the short run of the past few years, what change would this have on the aggregate market? Remember that in the short run, firms (farms in this case) cannot enter or exit the market. Draw two new graphs showing how this increased interest in organic vegetables

has changed the market. Mark the new short-run equilibrium price and quantity variables (P_2 , Q_2 , q_2).

This change in the market represents an increased demand for organic vegetables. This causes the demand curve to shift to the right.



- c. Are the individual farms making any profits in this short-run equilibrium? If so, mark the area on the graph that represents these profits.

Yes, because now farms are receiving a Price above their ATC, and this is the profit they earn on each unit sold. This is the area shaded in green on the previous graph.

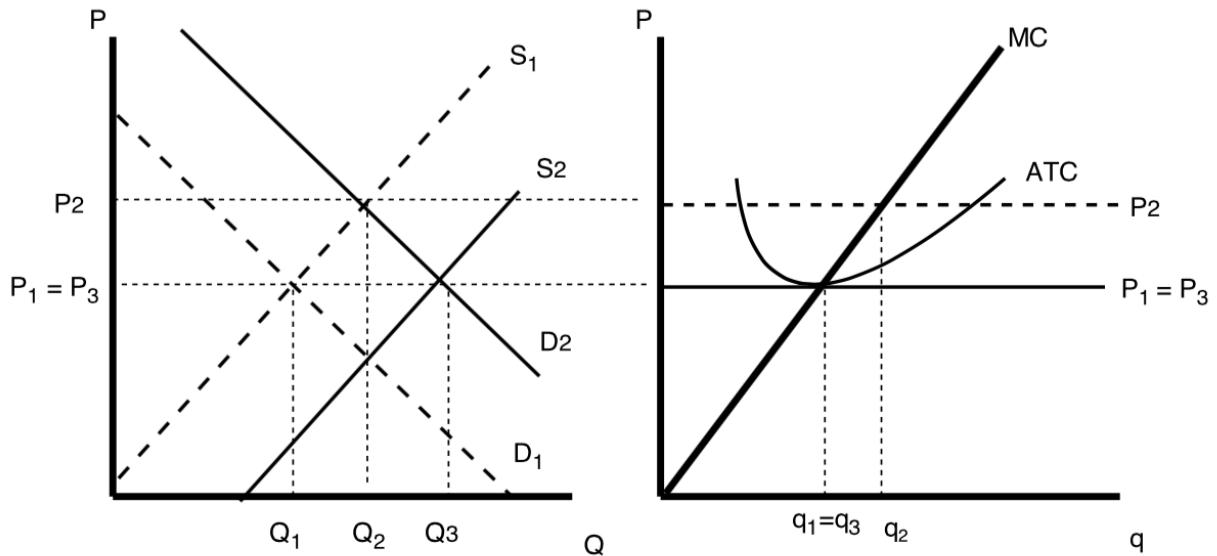
In the long run, existing farms are able to exit the market, and new farms are able to enter.

- d. Based on the answers to (b) and (c), will farms want to exit or enter the organic vegetable market?

Farms in this market are making positive profits, so new ones will want to enter.

- e. Draw two new graphs showing the new long-run equilibrium now that farms are allowed to enter and exit. Mark the new long-run equilibrium price and quantity variables (P_3 , Q_3 , q_3).

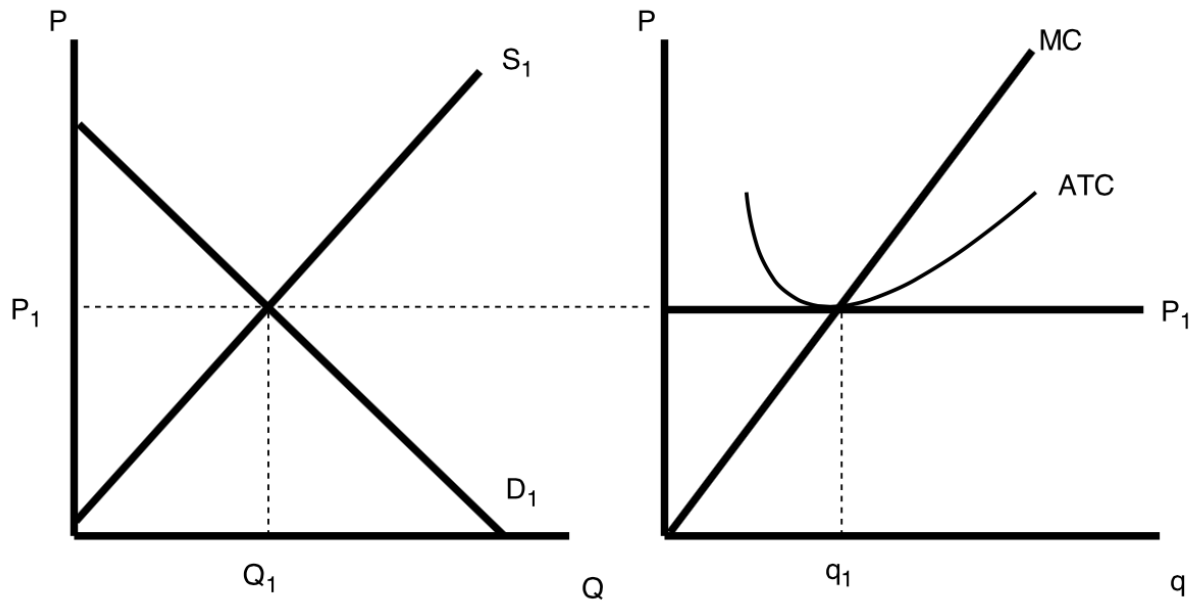
The entry of the additional firms causes the supply curve to shift to the right, and the price to fall. Each individual firm goes back to making $q_3 = q_1$ units, but the total quantity supplied increases to Q_3 .



- f. In this long run equilibrium, are the farms making any profits? If so, mark the area on the graph that represents these profits.

The price has dropped down to the Break Even point, so farms are not making any profit in this new long-run equilibrium. This will always be true of the long-run equilibrium in any perfectly competitive market.

- 5) Now we want to think about the perfectly competitive market for sugar. The approach will be just as in the previous problem.
- a. Begin by drawing two graphs representing a long-run equilibrium at the market level, and from the perspective of an individual sugar farm. Again be sure to mark (P_1, Q_1, q_1) .



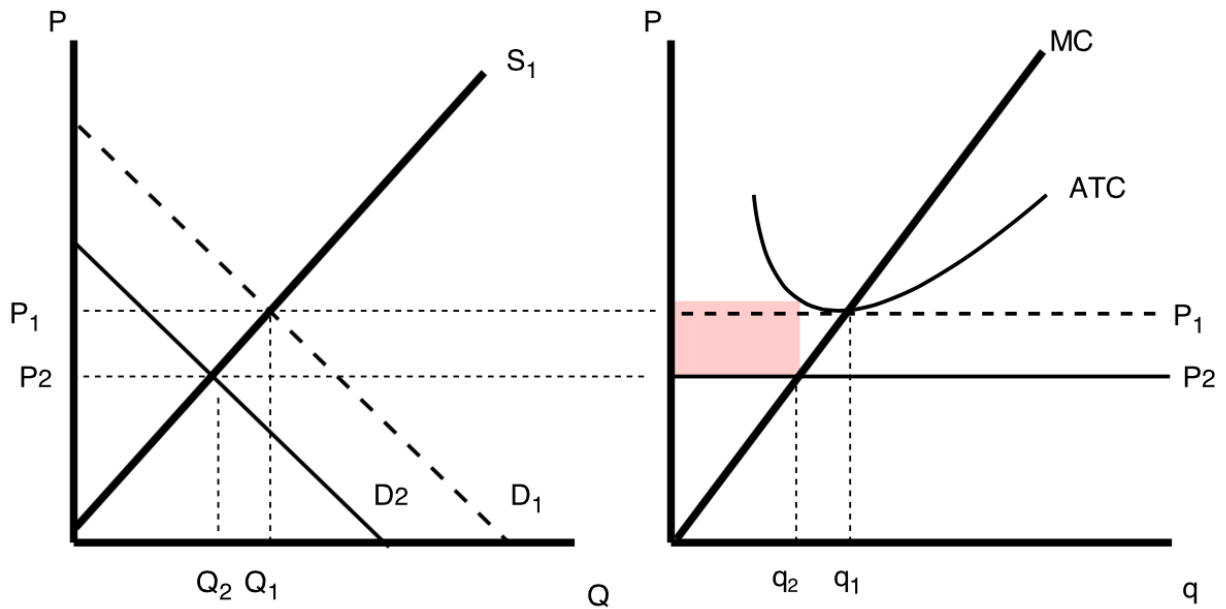
- b. In the initial long-run equilibrium, are farms making positive, negative, or zero profits?

The equilibrium price equals the Break Even price (minimum of ATC), so all farms are earning zero profits.

Food scientists have recently developed a number of new artificial sweeteners, which are good substitutes for sugar in many foods and drinks.

- c. What short-run effect would the introduction of these sweeteners have on the sugar market? Draw two new graphs to demonstrate how this affects the market as a whole, and the individual firms. Mark the new short-run equilibrium's P_2 , Q_2 , and q_2 .

If people start using the artificial sweeteners instead of real sugar, the demand for sugar will fall. This is reflected in the shift to D_2 on the graph.



- d. In this new short-run equilibrium, are farms making positive, negative, or zero profits?

The demand shift causes the short-run equilibrium price to fall below the break even price, so firms are making negative profits. The area representing these losses is shaded red in the graph above.

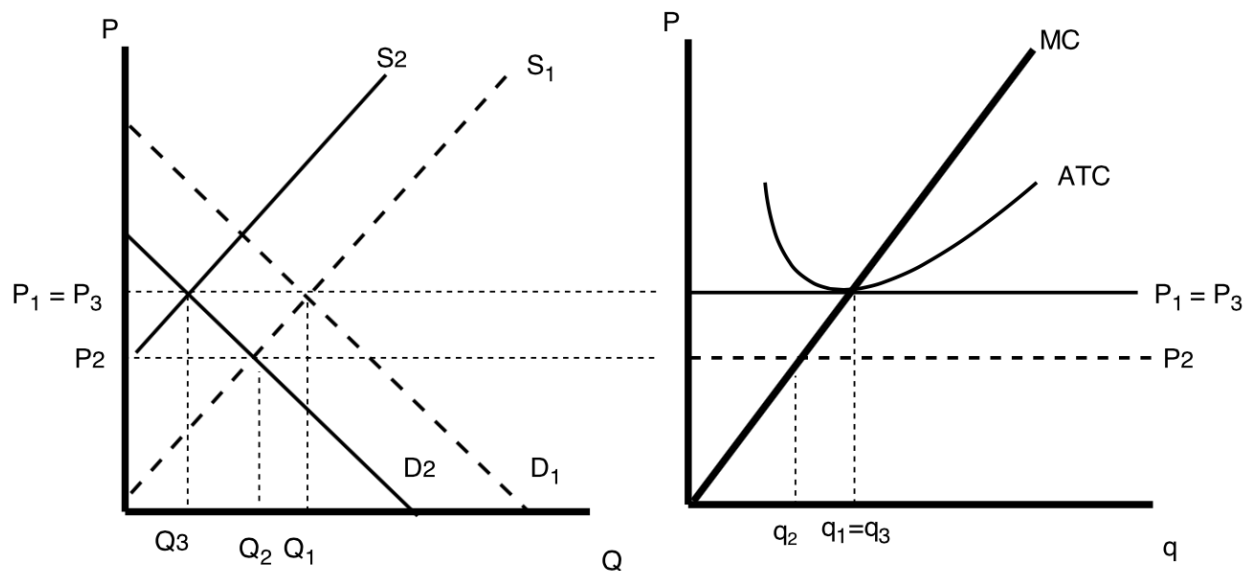
In the long run, sugar farmers can adapt to this market shift and enter or exit the sugar market.

- e. Will farmers be entering or exiting sugar farming? What fact drives this choice?

Given the negative profits, some farmers will choose to exit the market and stop growing sugar. This is because price is below the break even price (average total costs).

- f. Draw two more graphs based on the new long-run equilibrium that results from the introduction of the artificial sweeteners. Mark P_3 , Q_3 , and q_3 on the graphs.

The exit of some farmers will cause the supply curve to shift left, which in turn reduces total quantity, and raises price back up to the equilibrium level.



- g. Combining the results seen in this problem and problem (3), what might a rational farmer decide to do based on the market changes he or she observes? (*Note: this question was written by a grad student who knows nothing about farming. What potential issues might make this harder to do in real life than in our simple economic model?*)

It might seem like the change in consumers' tastes for organic vegetables and sugar would cause some farmers to shift from producing sugar to producing organic vegetables. This is an example of the power of the market to reallocate production to those goods which consumers value most highly.

As for problems... there may be many (climate, location, technology) which make it very difficult or impossible for some farmers to switch from growing sugar to growing vegetables. In our simple models we don't worry about these issues very much, but in reality there can definitely be winners and losers when consumers tastes change if it is costly for producers to adjust.

Exercise Looking at Careers

- 6) For this question go to the blog "Life's Curiosities: An Economist's Perspective". You can find this blog at <http://www.billkellyassociates.com/>. Once you are at the site, look around a bit and then proceed to this question.

Looking on the "Contents" page scroll down until you find "6. What's a Student to Do?" and "7. Amazing Career Database".

- a. Read the whole entry "What's a Student to Do?" and then read the entry "Check Out an Occupation". Study these articles carefully. What would you say are the two most important things to know from these articles? Write a short paragraph that highlights at least two points that you found interesting in these two entries. How did these readings

impact you? Did you learn something or did you find your thinking about your education altered because of these readings? Be thoughtful here. If you would like, shoot Bill Kelly a short (or long) email about the experience: his email is bkelly@bus.wisc.edu. (We want you to be part of our "focus group".)

Here's is Bill Kelly's quick response:

The two most important things I found out was first that I can benefit economically from learning what I would be especially good at, and second I can probably do better economically if I pay attention to the high and low end of salary ranges for each occupation I consider rather than comparing the median salaries across different occupations. I was impressed that I should focus on what occupation I am best at rather than what occupation has a higher median salary.

- b. Now go to the websites discussed in the article "Check Out an Occupation". Use the websites that are referred to in this article to research a potential career you think you are interested in. Find out information about this career from this data set. What is the salary for the top 10% of earners in this career? What is the salary for the bottom 10% of earners in this career? What particular skills and attributes are necessary to work in this profession?

Answer:

Both the Kellys are economists and we were both curious to see how "good a fit" there was for us individually in this profession! Here is first Bill Kelly's response followed by Professor Kelly's response in parentheses.

I checked out being a post-secondary teacher of economics. The 90th and 10th percentiles in salaries are, respectively \$174,000 and \$50,900, in Wisconsin. Speaking, writing, critical thinking, and administration are necessary to work in this profession. [Note from Professor Kelly: reflecting on the work I do on a regular basis I found the description of the work a post-secondary teacher of economics does is very accurate! And, a good fit for my talents: I am very organized, a good administrator, enjoy writing and public speaking- and teach a subject that requires critical thinking! Hurrah....there's a reason I love my job.]

- c. Repeat this process for another career that you think you might be interested in pursuing. I want you to look into careers that you find attractive or compelling since we are talking about YOUR LIFE.

See the answer at (d): since students will likely research different careers here there is no one set answer.

- d. For each of the careers you explored in (b) and (c) write separate paragraphs where you evaluate your current strengths, interests and attributes with regard to the specific career you researched. Do you think you are a potentially good fit for the career you researched?

If yes, explain why. If no, explain why. There should be two paragraphs minimum here since you are researching two different careers.

Answer:

From Bill: I think I am very good at critical thinking, good at writing and reasonably good at speaking. I am not so good at the administrative tasks involved.

From Professor Kelly: I think I am quite strong on the verbal, whether oral or written communication. I think I am very organized and therefore a strong administrator. I also think that I have a set of social skills that allows me to work well with large groups of students and in motivating large groups of students. I believe I am a very strong fit for the occupation that was described in the website.

- e. Write a final paragraph about how this experience impacted you. Did you learn anything from the experience? Were you introduced to datasets that were new to you? Did you find the undertaking an insightful experience? Expand on your answers here.

From Bill Kelly: I was surprised when I first discovered this data base with how thorough and relevant it was, and how potentially useful. I didn't have any idea that this much information on any one occupation was so readily available. It was insightful to see how much people earned at the top and bottom of the salary range, not just in the middle.