Solutions to the Student Practice Manual to Accompany

Microeconomics

B. Douglas Bernheim
Michael Whinston

Author:

Jennifer Pate, Ph.D.
Loyola Marymount University

Table of Contents

Chapter 1

1. A capitalist economy is more closely described as a free market system. In a free market system, the government usually lets markets operate freely with fewer regulations. In contrast to communist economies, capitalist economies are characterized by having a higher degree of decentralization, with the means of production primarily owned and controlled for the profit of private individuals.

2. Markets are institutions that supply economic agents (consumers, businesses, nations, etc…) with opportunities and procedures for buying and selling goods and services. A property right is an enforceable claim on a good or resource. Markets require property rights because the market system is dependent on the notion of ownership (which implies private property rights) and the possibility of transferring that ownership to another agent.

3. The principle of individual sovereignty enables economists to avoid paternalistic judgments. Applying the principle of individual sovereignty allows economists to turn a positive analysis into a normative analysis because invoking the principle of individual sovereignty allows economists to assume individuals have full knowledge of the consequences of their actions.

4. Economics is the study of how we allocate scarce resources using many different mechanisms, with one being price while also considering non-monetary methods. Money is but one of a long list of scarce resources. Other resources include, time, mineral resources, fresh water supplies, land, etc. Economics, specifically microeconomics, has grown into the study of decision making. Microeconomists study how individuals combine to produce social outcomes, and whether the outcomes achieved are desirable.

5. The best theories are ones that are generally applicable and specific in their implications. Theories that identify additional implications are paramount to developing a broadly applicable theory. In essence, a theory should try and explain as many things as it can without explaining things that it can't.

6. The social phenomena studied by economists are complex, for this reason, it helps when formulating a model to concentrate (simplify) assumptions in an effort to specifically address what is being studied, so to extract the phenomena's main causes and effects.

7. The three main categories of economic data are: Surveys, Records, and Experiments. Surveys are a method of collecting data that economists use because they can provide data on virtually any subject. Economists' main obtain survey data for a fee or free of charge in many cases. Records on financial accounts, personal records, and customer data, are typically kept by companies for their own research and analysis. Some of these records are open to the public, particularly for publicly traded companies, and they may be obtained for a fee or free of charge.

8. Economists use experimental data obtained by conducting economic experiments to test theories of both markets and consumer behavior. The cost of obtaining experimental data is related to the cost of designing and running the experiment. Disagreements between economists over positive matters typically arise when economists start with different assumptions, which in turn may lead to contrasting scientific conclusions or judgments.

9. In a controlled experiment, economists isolate causal relationships by design, whereby they typically have control and treatment groups. A natural experiment differs from a controlled experiment primarily because they occur naturally without design but they produce similar effects. Natural experiments create a situation where by chance two otherwise identical groups may differ, creating the same effect as separating subjects into controlled and treatment groups.

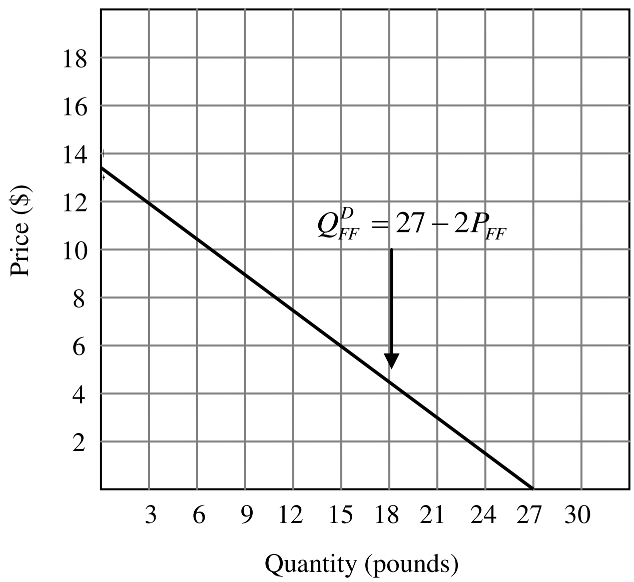
10. The cost and benefit associated with buying and selling goods and services depends on their prices. Thus, changes in the price of those goods and services generally changes people's choices. An increase (decrease) in the price of a good raises (lowers) the cost to buy, thereby creating a disincentive (incentive) to buy.

11. Trade can benefit two people at the same time for several reasons. Trade allows people to exchange something they own that is of relatively lesser value, for a good or service that is of relatively greater value. Trade also allows workers, countries, companies, etc. to specialize in producing goods and or services they produce well.

12. With environmental policy, those who stand to gain from a public policy may exaggerate its benefit, while those who stand to lose may do the opposite. The tools learned in microeconomics are essential to the analysis of public policy because they can recognize beneficial policies and produce objective measures of the costs and benefits to society.

Chapter 2

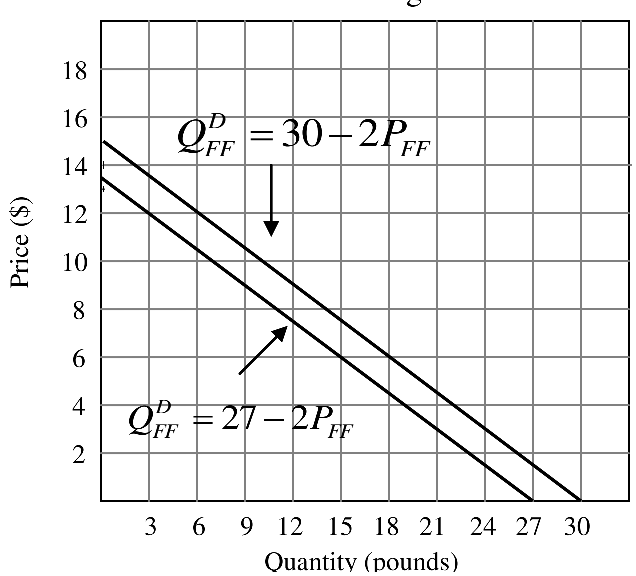
1.



The function is: $Q_{FF}^D = 27 - 2P_{FF}$
Y-intercept (Price) = 13.5 & X-intercept (Quantity) = 27

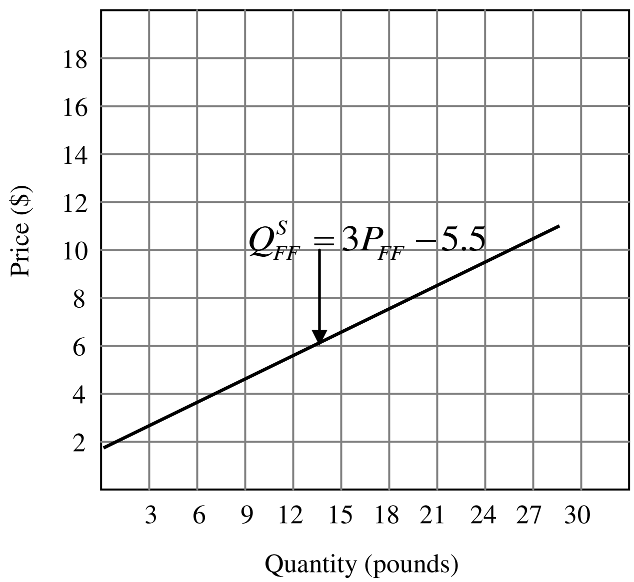
2. Set 15 equal to Q_{FF}^D, then solve for P_{FF}. At the price $P_{FF} = \$6.00$, the quantity demanded of French fries will be 15 million. If $P_K = \$5.00 \Rightarrow Q_{FF}^D = 24.5 - 2P_{FF}$. This change in the price of ketchup will shift the demand for French fries to the left. Using this new demand function and setting Q_{FF}^D equal to 15, solve for P_{FF}. At the price $P_{FF} = \$4.75$, the quantity demanded of French fries will be 15 million.

3. The demand curve shifts to the right.



4. To determine whether French fries and onion rings are substitutes or complements, evaluate what happens to Q_{FF}^{D} as the price of onion rings increases (or decreases). Given demand function from (1), if the price of onion rings increases this would have a positive effect on Q_{FF}^{D} . Since in increase in the price of onion rings leads to an increase in the quantity of French fries demanded, we can conclude that French fries and onion rings are substitutes.

5.

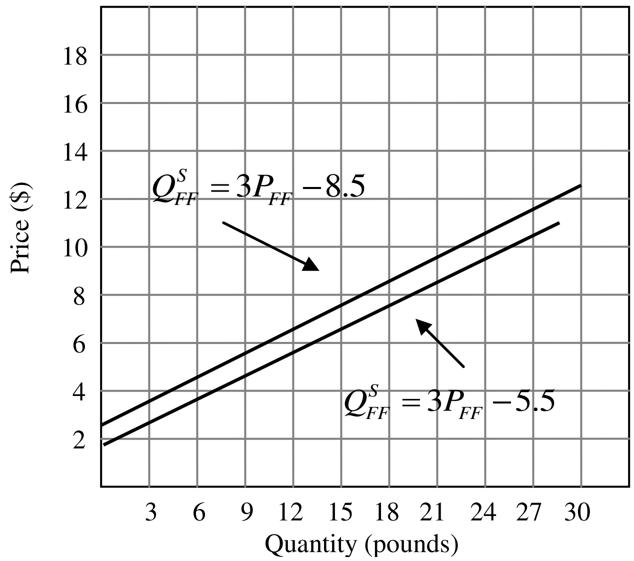


The Y-intercept (Price) = 1.83

6. At a P_{FF} = \$6.00 the quantity supplied of French Fries will equal 12.5 million pounds. Evaluating the equation from question 5, a decrease in the price of potato flakes to \$3.00 will increase the quantity supplied of French fries. The new supply function will be $Q_{FF}^{S} = -2.5 + 3P_{FF}$. Using this new supply function and setting Q_{FF}^{S} equal to 12.5, solve for P_{FF} . At the price $P_{FF} = \$5.00$, the quantity demanded of French fries will be 12.5 million.

7. In the answer to (6) we see that as the price of potato flakes decreases, the quantity of French fries supplied increases, demonstrating that the two goods are substitutes in production.

8. New Y-intercept (Price) = 2.33. If the price of frying oil increases, the supply of French fries shifts to the left.



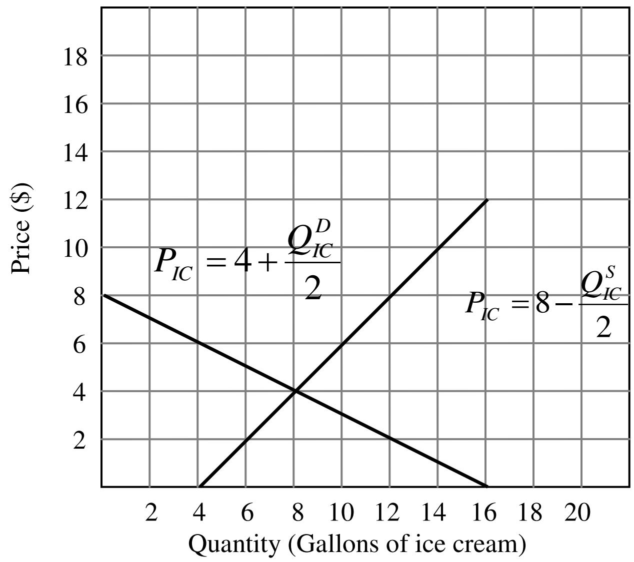
9. $P_{FF} = \$6.00$; $Q_{FF}^{D} = 8$ million lbs.; $Q_{FF}^{S} = 8$ million lbs.

10. $P_{FF} = \$5.00$; $Q_{FF}^{D} = 5$ million lbs.; $Q_{FF}^{S} = 5$ million lbs.

11. $P_{FF} = \$5.00$; $Q_{FF}^{D} = 10$ million lbs.; $Q_{FF}^{S} = 10$ million lbs.

12. $P_{FF} = \$4.00$; $Q_{FF}^{D} = 7$ million lbs.; $Q_{FF}^{S} = 7$ million lbs. The quantity decreased from question (9), indicating that the decrease in demand was larger than the increase in supply.

13. The equilibrium price for the market is $4.00. At this price 8 gallons of ice cream are bought and 8 gallons of ice cream are sold. See the graph below.



14. Elasticity of demand at $P_{FF} = \$3.50: \ \frac{-7}{13} \approx -0.54$

    Elasticity of demand at $P_{FF} = \$5.00: -1$

15. Elasticity of supply at $P_{FF} = \$3.50: \ \frac{10.5}{0.5} \approx 21$

    Elasticity of supply at $P_{FF} = \$5.00: \ \frac{15}{5} \approx 3$

16. The total expenditure will be the largest when the elasticity of demand equals -1.
    At $P_{FF} = \$5.00$ total expenditure will be largest.

Chapter 3

1. The opportunity cost of going to see the movie is not being able to go to the gym. Working out at the gym represents your opportunity cost in this case because it is your next best alternative according to your preference rakings. If going to see a movie was not an option and you had chosen to go to the gym, your opportunity cost would be time not spent reading your book.

2. It is important to make decisions based on the net benefit of your options because it takes both the total benefit and total costs into consideration. Making a decision based only on the total benefit would not consider the costs associated with that option

3.

Hours	Benefit	Cost	Net Benefit
0	0	0	0
1	460	80	380
2	840	220	620
3	1140	420	720
4	1360	680	680
5	1500	1000	500
6	1560	1380	180

The best possible option here is the one with the highest net benefit. This would be where you employ your mechanic for 3 hours and your net benefit is $720.

4.

Hours	Benefit	Cost	Net Benefit
0	0	0	0
1	460	80	330
2	840	220	520
3	1140	420	570
4	1360	680	480
5	1500	1000	250
6	1560	1380	120

The additional $50 hourly fee has the effect of increasing the costs of getting your car fixed, and decreasing the net benefit. The maximum net benefit now is $570, however, it remains most beneficial to hire your mechanic for 3 hours.

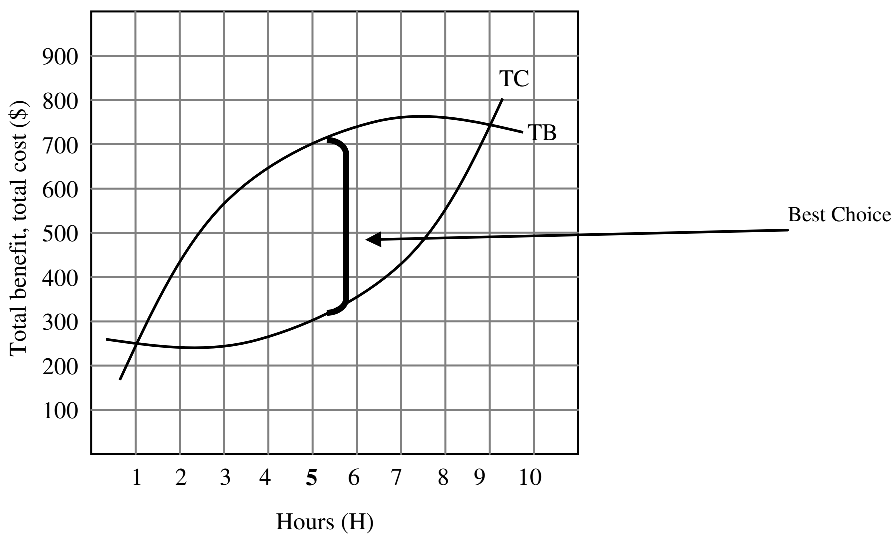
5.

Hours	Benefit	Marginal Benefit	Cost	Marginal Cost
1	460	460	80	80
2	840	380	220	140
3	1140	300	420	200
4	1360	220	680	260
5	1500	140	1000	320
6	1560	60	1380	380

The best choice according to this schedule is to hire your mechanic for three hours. The three hour mark is the last point at which the marginal benefit exceeds the marginal cost. This is in accordance with the principle of *No Marginal Improvement*, which states that "at a best choice, the marginal benefit of the last unit must be at least as large as the marginal cost, and the marginal benefit of the next unit must be no greater than the marginal cost."

6. The best choice according to total cost and total benefit functions can be found by equating the respective marginal benefit and marginal cost curves, and then solving for H: $500 - 80H = 50 + 60H \Rightarrow H \approx 3.21$
   So hiring the mechanic for about 3.2 hours is your best choice.

7. The graph below provides us with similar information as charts from previous problems. To find the best choice we merely have to look for the largest vertical distance between the total benefit and total cost curves (Note: the only relevant portion of the graph is where TB > TC, because points that lie where TC < TB are clearly not best choices) this strategy will ensure that we have identified the largest net benefit.



8. The best choice according to total cost and total benefit functions can be found by equating the respective marginal benefit and marginal cost curves, and then solving for H: $350 - 15H = 40 + 50H \Rightarrow H \approx 4.77$. So the best solution is $H \approx 4.77$.

9.

Hours	Benefit	Cost	Net Benefit
0	0	0	0
1	335	65	300
2	640	180	460
3	915	345	570
4	1160	560	600
5	1375	825	550
6	1560	1140	420

According to the chart above, hiring your mechanic for 4 hours is the best choice, because it has the largest net benefit of any of the possible choices.

10. Introducing a one-time non-refundable consultation fee of $100 would have the effect of changing your total cost function from, $C(H) = 40H + 25H^2$ to $C_{new}(H) = 100 + 40H + 25H^2$. On the graph from (8) the TC curve would be shifted up by 100 units. Despite this shift in the TC curve this does not change the marginal cost curve (if you know calculus you could verify this by taking the derivative of the new TC function and find that it is the same as the old marginal cost function). Since the MC function and the MB function are the same you will find that your best choice from (8) is the same, even after adding a one-time consultation fee. The consultation fee is what is known as a sunk cost. Sunk costs have no effect on your best choice because regardless of how many hours you employ your mechanic the consultation fee is constant.

11. Sunk costs should be ignored when finding the best choice from a set of options because for one they are unavoidable. More importantly, sunk costs have no effect on marginal costs.

12. The principle of *No Marginal Improvement* tells us that the best choice can be found by setting MB = MC. To check this you can see the point where MB = MC, then look at points just above and points just below on the MB curve. The best choice is characterized by the fact that points just above or below will not produce a greater net benefit. Then compare the net benefits at any boundary point to the net benefit at the interior action that you found by setting MB = MC to choose the best choice.

13. The best choice is found by setting MB = MC (by *No Marginal Improvement Principle)*:

$$MB(H) = 110 - 20H = MC(H) = 50 + 140H$$

$$\Rightarrow H \approx \frac{1}{2} \text{hours.}$$

If the mechanic requires a 1-hour minimum payment then it would be better not to take your car to the mechanic (choose H = 0). By the No Marginal Improvement Principle, if you increased the units of H to 1 hour MB < MC and thus the net benefit will be negative.

14. The difference between an interior action and a boundary action is that in a boundary action the level of activity can only be changed in one direction. An interior action's activity level may be increased or decreased. It is important to eliminate boundary choices because it is possible that boundary choices contain a higher net benefit than your best interior choice. Eliminating them assures you that you have indeed found the best choice.

15. The choice you make will depend on which option (4 or 5 hours) gives you a higher net benefit. If the MB grows smaller and MC grows larger as the number of hours increase, then 4 hours would be a better choice.

Chapter 4

1. It is important that consumers follow the choice principle because it allows them to select, among available alternatives, which one ranks highest. If the choice principle did not apply we could not assume when formulating economic theories that consumers are rational. Assuming consumers are rational is an important assumption economists make when they model economic phenomena, as we saw from chapter 1.

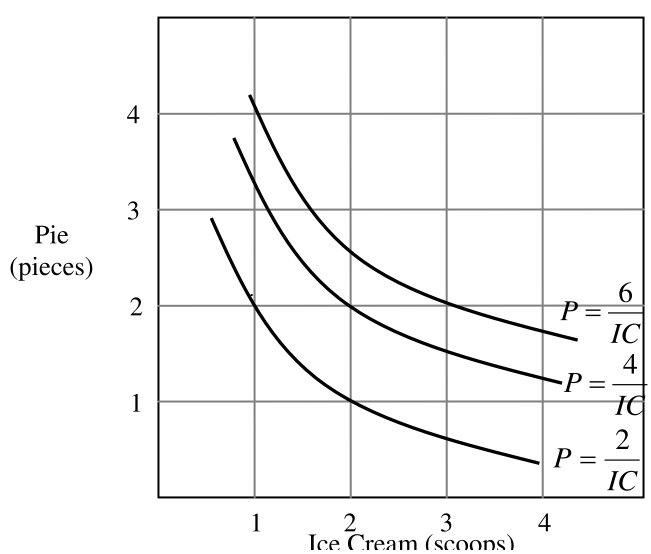
2. In this example, Stephanie clearly enjoys both pie and ice cream, and her rankings show that her most preferred bundle contains the maximum of 3 slices of pie, and 3 scoops of ice cream. The more-is-better principle is clear if you look at how Stephanie clearly prefers having 1 slice of pie and 1 scoop of ice cream over having either 3 slices of pie and 0 scoops of ice cream and vice a versa. Also notice that Stephanie's preferences satisfy the more-is-better principle because in any particular column the numbers at the top are smaller than the numbers at the bottom.

3. a) No, she would swap $(9 \text{ f } 13)$. b) No, she will not swap $(9 \,\phi\, 10)$. c) No, she will not swap $(9 \,\phi\, 11)$.

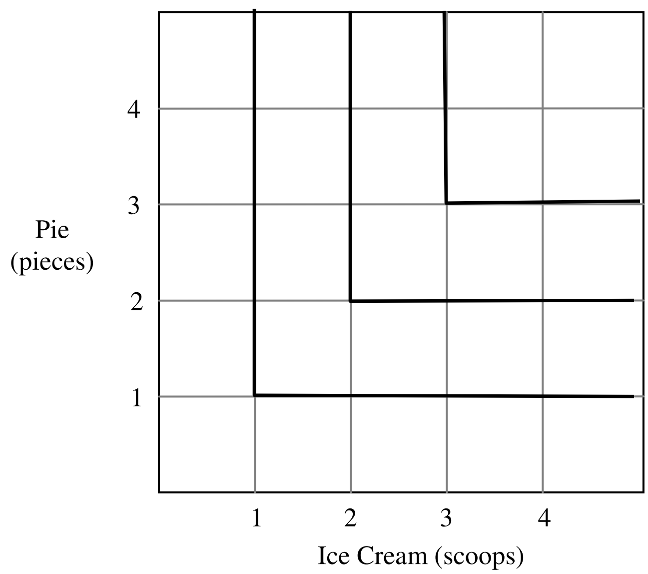
4. Yes, the ranking principle does allow for ties, which allows for a consumer to be indifferent or equally like (dislike) an alternative(s). This means that Stephanie may be indifferent about any number of her alternatives, as is clear in her indifference between having 1 slice of pie and no scoops of ice cream, or vice versa; and still be considered a rational consumer.

5. D is most preferred (by the more-is-better principle). Both B and E are equally preferred because they are on the same indifference curve (2nd most preferred). 3rd most preferred is C, and the least preferred bundle is A. This may also be represented in the following form ($D \,\phi\, (B \sim E) \,\phi\, C \,\phi\, A$).

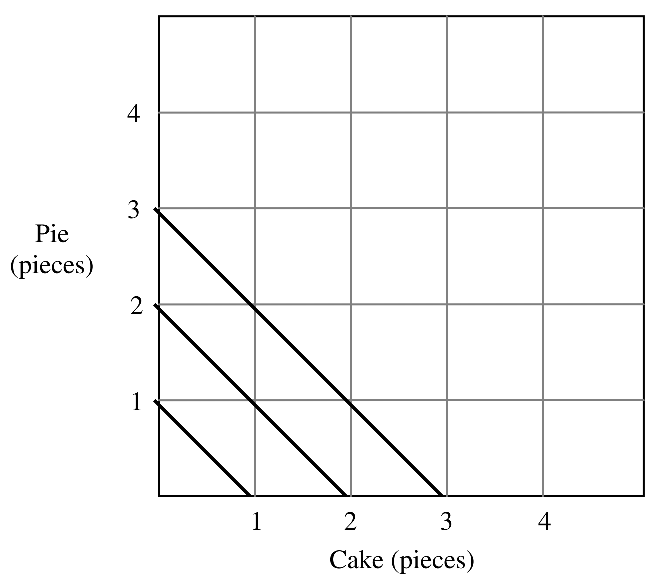
6.



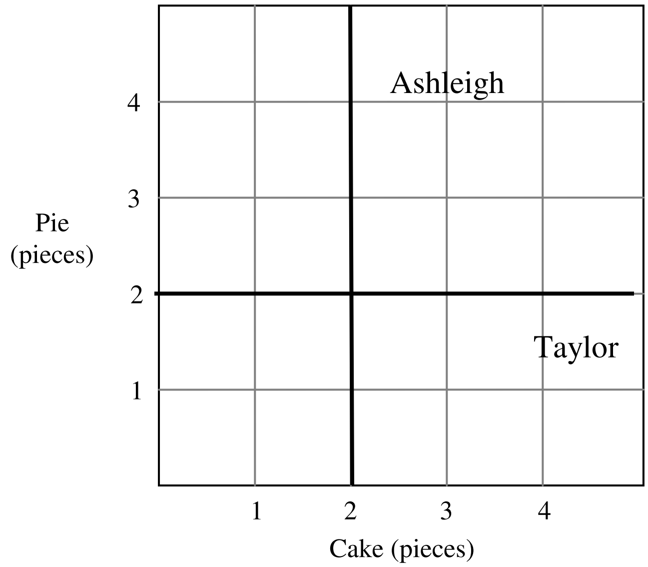
7. This type of preference is called perfect complements.



8.



9.



The graphs shows that given 2 pieces of cake Ashleigh could not be made better off by giving her any amount of pie. Conversely, the graph also shows that given 2 pieces of pie Taylor could not be made better off by giving her any amount of cake.

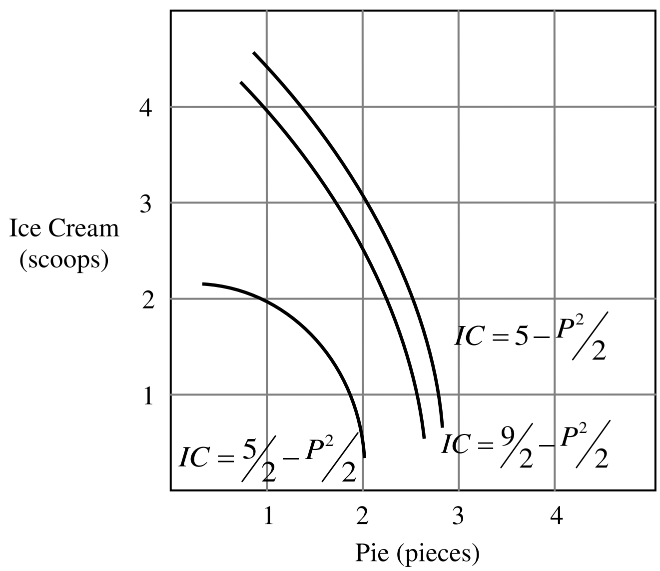
10. Use Stephanie's utility function to find to help find the order of preference. For example for (a): $U(1,4) = 1^2 + 2(4) = 9.$ The rest are as follows: $U(0,5) = 0^2 + 2(5) = 10,$ $U(4,0) = 4^2 + 2(0) = 16,$ $U(2,3) = 2^2 + 2(3) = 10.$ Therefore, Stephanie's preferences are as follows: 1st, 4 pieces of pie and no ice cream; 2nd, both (b) and (d), no pie and 5 scoops of ice cream, and 2 pieces of pie and 3 scoops of ice cream; and lastly, 1 piece of pie and 4 scoops of ice cream.

11. Given Stephanie's utility function the formula for her indifference curves can be found by rearranging the equation and solving for IC, as such: $U(P,IC) = P^2 + 2IC \Rightarrow 2IC = U(P,IC) - P^2 \;\; \Rightarrow IC = {}^{U}\!/_{2} + {}^{P^2}\!/_{2}.$ Stephanie's marginal utility of pie is $MU_{Pie} = 2P,$ (adding ΔP increases the utility value by 2P so, $\dfrac{\Delta U}{\Delta P} = 2P.$ The marginal utility of ice cream is $MU_{IC} = 2,$ (adding ΔIC the utility value by 2 so, $\dfrac{\Delta U}{\Delta IC} = 2.$ Now, to find Stephanie's marginal rate of substation for pie with ice cream use the equations for finding the MRS with the information about the marginal utilities of both pie and ice cream, as such:

$$MRS_{P,IC} = \frac{MU_P}{MU_{IC}} = \frac{2P}{2} = P.$$

Her MRS of pie with ice cream is P scoops of ice cream per piece of pie.

12.



To find the equations for the indifference curves use the information given and the equation you found for indifference curves in (11) so:

If $U(P,IC) = 5$, then $IC = 5/2 - P^2/2$

If $U(P,IC) = 9$, then $IC = 9/2 - P^2/2$

If $U(P,IC) = 10$, then $IC = 5 - P^2/2$

13. Finding the indifference curves is simply a matter of solving the utility function given in terms of P like so (note: for simplicity U(P,IC) = U):

$$U(P,IC) = P^{2/3} \times IC^{1/3} \Rightarrow IC^{1/3} = \frac{U}{P^{2/3}}, \ \Rightarrow IC = \left(\frac{U}{P^{2/3}}\right)^{1/3}.$$

To find Dave's marginal utility of pie we can use some basic calculus:

$$U(P,IC) = P^{2/3} \times IC^{1/3}$$

$$\Rightarrow MU_P = \frac{2}{3} P^{-1/3} \times IC^{1/3},$$

$$\Rightarrow MU_P = \frac{2}{3}\left(\frac{IC}{P}\right)^{1/3}.$$

Finding Dave's marginal utility of ice cream can be done in the same fashion:

$$U(P,IC) = P^{2/3} \times IC^{1/3}$$

$$\Rightarrow MU_{IC} = \frac{1}{3} P^{2/3} \times IC^{-2/3},$$

$$\Rightarrow MU_{IC} = \frac{1}{3}\left(\frac{P}{IC}\right)^{2/3}.$$

Finding the MRS of pie with ice cream can be done as follows:

$$MRS_{P,IC} = \frac{MU_P}{MU_{IC}} = \frac{\frac{2}{3}\left(\frac{IC}{P}\right)^{1/3}}{\frac{1}{3}\left(\frac{P}{IC}\right)^{2/3}} = 2\left(\frac{IC}{P}\right)^{1/3}\left(\frac{IC}{P}\right)^{2/3} = 2\left(\frac{IC}{P}\right).$$

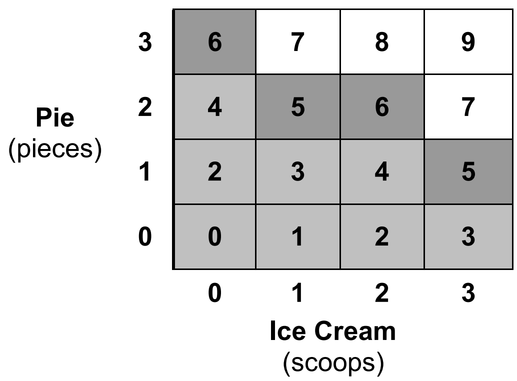
14. Yes, Dave would be willing to trade because his utility at a bundle of 2 pieces of pie and 1 scoop of ice cream is greater than his first bundle of 1 piece of pie and 2 scoops of ice cream.

    To see this simply use Dave's utility function with the appropriate bundle, as such:
    $U(1,2) = (1)^{2/3}(2)^{1/3} \approx 1.26$
    $U(2,1) = (2)^{2/3}(1)^{1/3} \approx 1.59.$
    $\therefore U(1,2) = 1.26 < U(2,1) = 1.59$.

15. There is certainly a trade that could improve both of their positions. This assertion can be verified as follows: if Stephanie has 4 scoops of ice cream her utility function is: $U = 0 + 2(4) = 8.$ If Dave has 3 pieces of pie his utility function is: $U = (3)^{2/3}(0)^{1/3} = 0$. If Dave gives Stephanie 1 piece of pie for 1 scoop of ice cream, Stephanie's utility would increase to $U = 2^2 + 2(3) = 10.$ Dave's utility would also increase to $U = (2)^{2/3}(1)^{1/3} = 1.58$, therefore this trade is beneficial to both Stephanie and Dave.

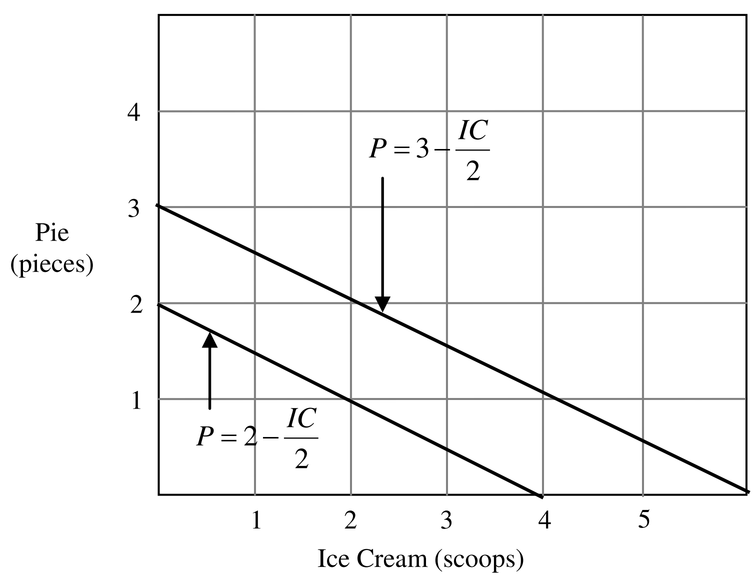
Chapter 5

1.



If Stephanie's income is \$4.00 her affordable options are lightly shaded. If Stephanie's income is increased to \$6.00 her affordable options increase to include the lightly shaded regions and the more darkly shaded regions.

2.

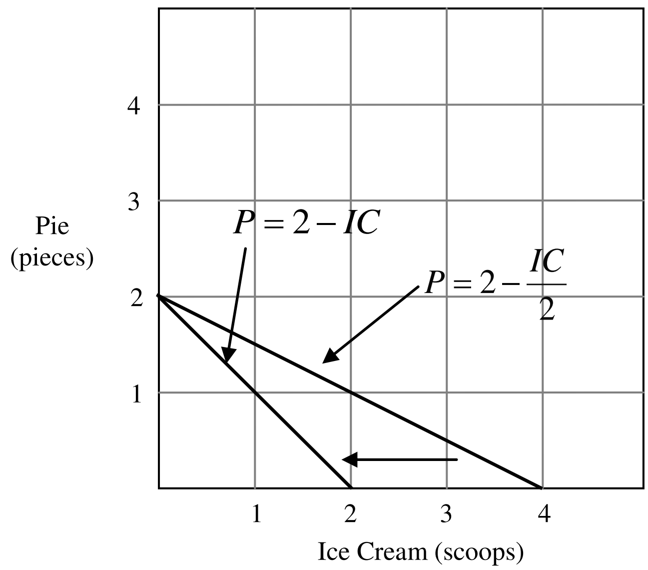


If Stephanie's income is \$4.00 the horizontal intercept is 4 scoops of ice cream, and the vertical intercept is 2 pieces of pie. The slope of the line is $-\frac{1}{2}$.

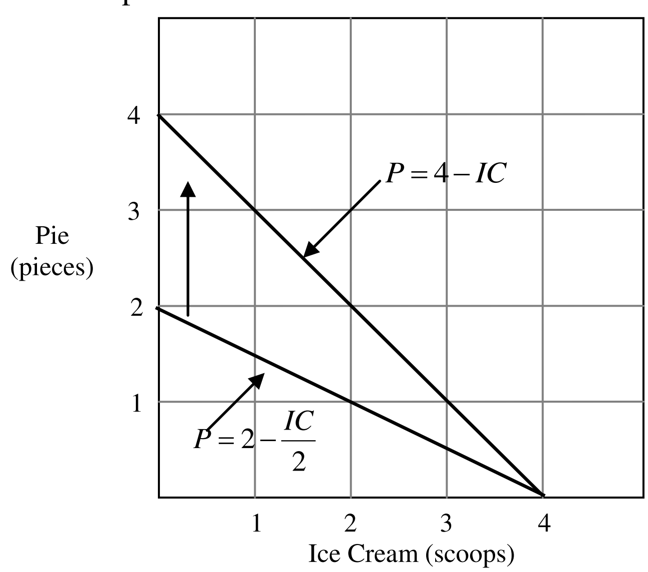
As Stephanie's income increases from \$4.00 to \$6.00 her budget line shifts right. If Stephanie's income is \$6.00 the horizontal intercept is 6 scoops of ice cream, and the vertical intercept is 3 pieces of pie.

3. If the price of ice cream doubles to \$2.00 the new budget line is $P = 2 - IC$. Her new budget line has a slope of -1, with a horizontal intercept at 2 scoops of ice cream, and a vertical intercept at 2 pieces of pie.

   The number of affordable options has decreased due to the increase in the price of ice cream scoops. This increase in the price of ice cream has caused the original budget line to rotate inward from the origin (pivoting at the intercept for pie).



4. Stephanie's new budget line is $P = 4 - IC$. The slope of this budget line is -1, with a horizontal intercept at 4 scoops of ice cream and a vertical intercept at 4 pieces of pie. The number of affordable options has increased due to the fact that the price of pie decreased from \$2.00 to \$1.00. Graphically this is represented by a rotation upward, pivoting at the intercept for ice cream.



5. The unaffordable bundles are lightly shaded below. Of the affordable bundles, the one that would give Stephanie the most utility is the bundle with 2 scoops of ice cream and 1 piece of pie. This bundle corresponds to her highest ranking (8) affordable option.

Pie (pieces)				
3	10	5	2	1
2	12	7	4	3
1	14	9	**8**	6
0	15	14	13	11
	0	**1**	**2**	**3**

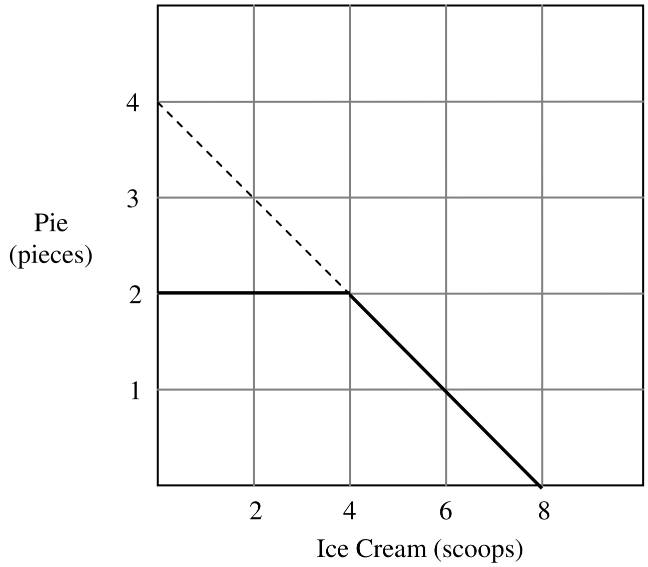
Ice Cream
(scoops)

6. With an income of $6.00 Stephanie's unaffordable options are highlighted in green. Of he affordable bundles, the one that would give Stephanie the most utility is the bundle with 2 pieces of pie and 2 scoops of ice cream. This bundle corresponds to her highest ranking (4) affordable option.

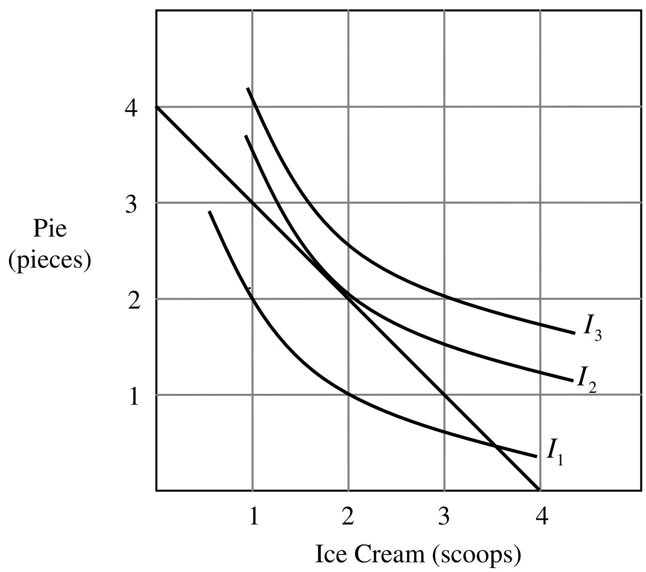
Pie (pieces)				
3	10	5	2	1
2	12	7	**4**	3
1	14	9	8	6
0	15	14	13	11
	0	**1**	**2**	**3**

Ice Cream
(scoops)

7. The introduction of pie rationing forces to Stephanie to forgo her otherwise affordable and highest ranked option (#2: 3 pieces of pie, 2 scoops ice cream), and accept her next best option (#3: 2 pieces of pie, 3 scoops of ice cream).



8. Indifference curve (I_2) achieves Stephanie's utility-maximizing bundle because I_2 does not overlap with the area below the budget line.



9. It is important for the budget line to be tangent to the indifference curve at a utility-maximizing bundle for interior solutions because an indifference curve going through any interior choice that not satisfy the tangency condition thus creating an overlap between the areas below the budget line and above the indifference curve. Boundary solutions are excluded from the tangency condition because at a boundary solution the slope of the budget line and the slope of the indifference curve are not equal.

10. First, derive the equation for the budget line as follows:

$$P_B B + P_C C = Income.$$
$$\Rightarrow 10B + 5C = 50$$
$$\Rightarrow C = 10 - 2B. \quad \text{(Budget line)}$$
$$\frac{P_C}{P_B} = \frac{\$5.00}{\$10.00} = \frac{1}{2}.$$

Now, use the tangency condition to help solve for B:

$$MRS_{CB} = \frac{B}{C} = \frac{1}{2} = \frac{P_C}{P_B}$$
$$C = 2B$$

Next, use the previous result along with the equation for the budget line to solve for C and B:

$$C = 10 - 2B \Leftrightarrow (2B) = 10 - 2B$$
$$\Rightarrow 4B = 10$$
$$\Rightarrow B = 2.5$$

Now use B to find C.

$$C = 2B$$
$$\Rightarrow C = 2(2.5)$$
$$\Rightarrow C = 5$$

If Holly's marginal rate of substitutions for candy with balloons is $MRS_{CB} = \frac{B}{C}$, then she should buy 5 pounds of candy and 2.5 packages of balloons.

11. Use the tangency condition to solve for B in terms of C:

$$MRS_{CB} = \frac{B}{2C} = \frac{1}{2} = \frac{P_C}{P_B}$$
$$\Rightarrow B = C.$$

Now use the previous result and the budget line to solve for C and B:

$$C = 10 - 2(C)$$
$$\Rightarrow 3C = 10$$
$$\Rightarrow C = \frac{10}{3} \approx 3.33$$

Solving for B:

$$B = C$$
$$\Rightarrow B = \frac{10}{3} \approx 3.33$$

With this marginal rate of substitution Holly should buy 3.33 pounds of candy and 3.33 packages of balloons.

12. First, substitute $MU_C = B,\ MU_B = C,\ P_C = \$5,\ P_B = \$10$ into formula (6) (p141) from the text to find an interior optimum.

$$\frac{MU_C}{P_C} = \frac{MU_B}{P_B} \Rightarrow \frac{B}{5} = \frac{C}{10} \Rightarrow 2B = C.$$

Next, use the previous result by substituting into the budget line $C = 10 - 2B$ to solve for B and C.

$$C = 10 - 2B \Rightarrow 2B = 10 - 2B \Rightarrow B = \frac{10}{4} = 2.5.$$

Solving for C:

$$C = 10 - 2(2.5) \Rightarrow C = 5.$$

Therefore, Holly should buy 5 pounds of candy and 2.5 packages of balloons.

13. First, substitute $MU_C = 2 + B$, $MU_B = C$, $P_C = \$5$, and $P_B = \$10$ into the formula $\frac{MU_C}{P_C} = \frac{MU_B}{P_B}$.

$$\frac{MU_C}{P_C} = \frac{MU_B}{P_B} \Rightarrow \frac{2+B}{5} = \frac{C}{10} \Rightarrow 2B = C.$$

Next, solve for B and C using the budget line.

$$C = 10 - 2B \Rightarrow 2B = 10 - 2B \Rightarrow B = 1.5.$$

Solving for C:

$$C = 10 - 2(1.5) \Rightarrow C = 7.$$

Therefore, Holly will buy 1.5 packages of balloons and 7 pounds of candy for her classroom.

14. To calculate the optimal amounts of candy and balloons at \$5 and \$10 set up the budget lines at the different prices of balloons:
If balloons cost \$5: $C = 10 - B$

Next set up the following:

$$MRS_{CB} = \frac{B}{C} = \frac{5}{5} = \frac{P_C}{P_B} \Rightarrow B = C.$$

Use the budget line to solve for B and C:
$B = 10 - B \Rightarrow B = 5.$
$C = 5.$
If balloons cost \$10: $C = 10 - 2B.$

Next set up the following:

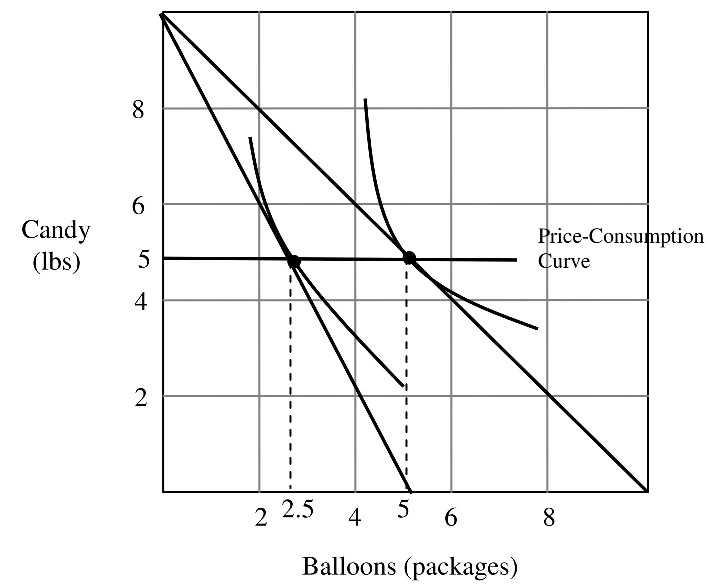
$$MRS_{CB} = \frac{B}{C} = \frac{5}{10} = \frac{P_C}{P_B} \Rightarrow 2B = C.$$

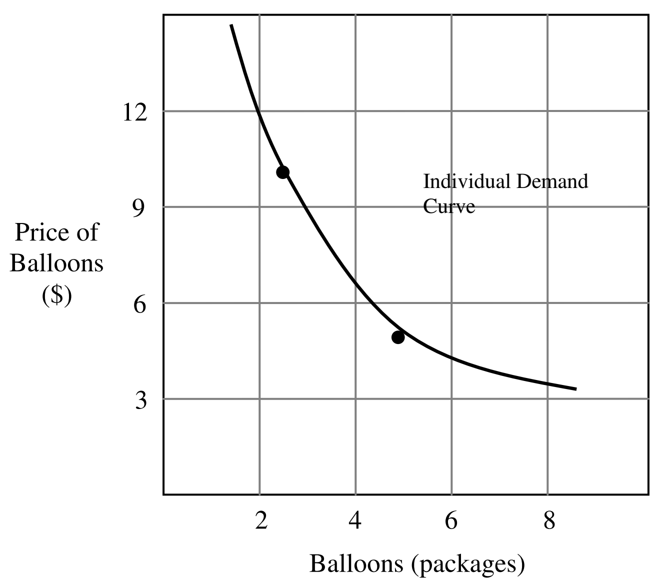
Use the budget line to solve for B and C:

$2B = 10 - 2B \Rightarrow B = 2.5.$

$C = 5.$

Use the information above to plot the graphs for the budget lines, optimal solutions, and finally the price-consumption curve.





15. To calculate the optimal amounts of candy and balloons at \$5 and \$10 set up the budget lines at the different prices of balloons:

If balloons cost \$5: $C = 10 - B$

Next set up the following:

$$MRS_{CB} = \frac{2+B}{C} = \frac{5}{5} = \frac{P_C}{P_B} \Rightarrow 2 + B = C.$$

Use the budget line to solve for B and C:

$$2 + B = 10 - B \Rightarrow B = 4.$$
$$C = 6.$$

If balloons cost \$10: $C = 10 - 2B.$

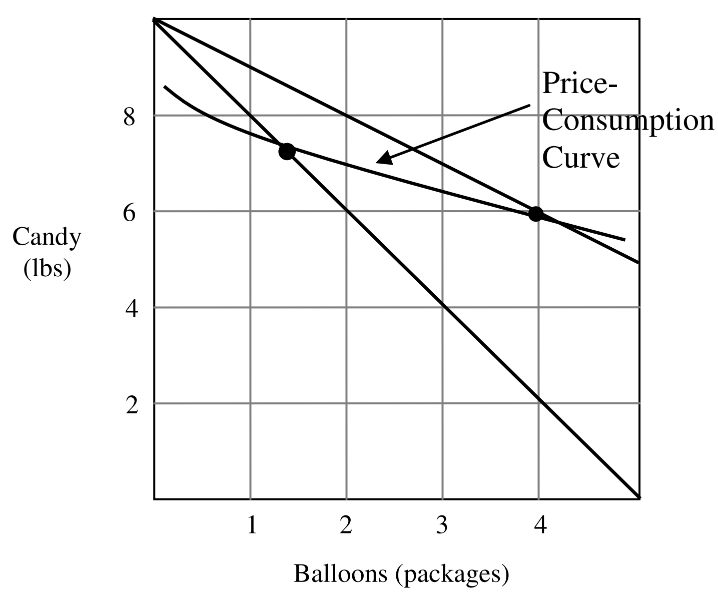
Next set up the following:

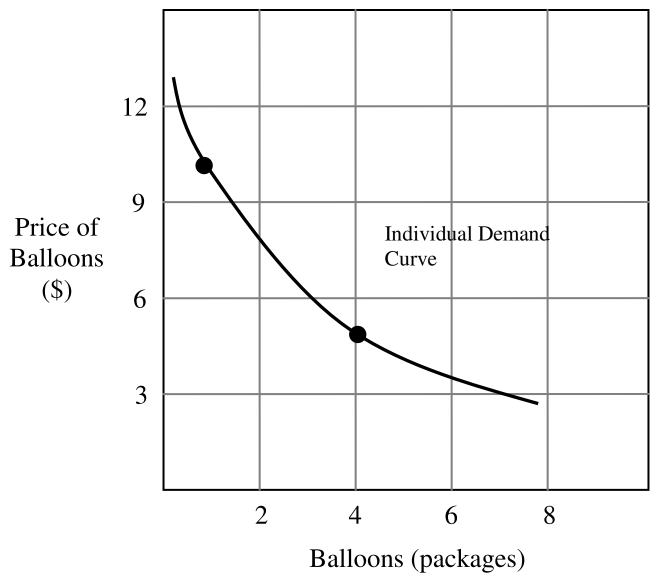
$$MRS_{CB} = \frac{2+B}{C} = \frac{5}{10} = \frac{P_C}{P_B} \Rightarrow 4 + 2B = C.$$

Use the budget line to solve for B and C:

$$4 + 2B = 10 - 2B \Rightarrow B = 1.5.$$
$$C = 7.$$

Use the information above to plot the graphs for the budget lines, optimal solutions, and finally the price-consumption curve.



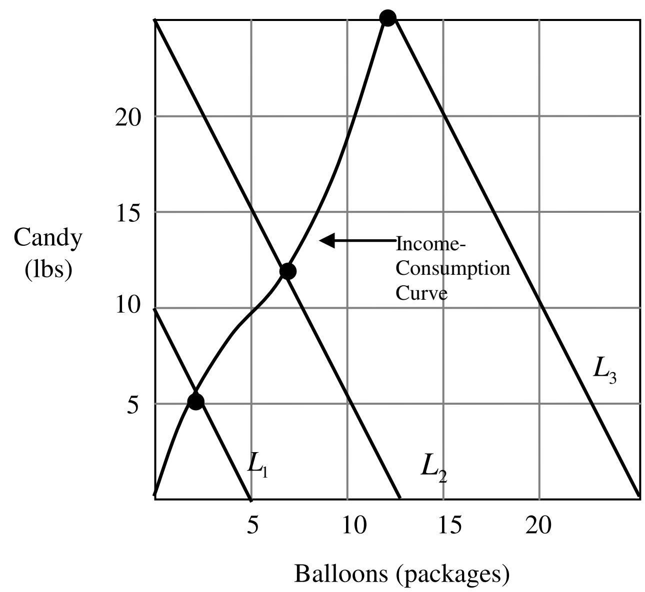


16. To plot the Income-consumption curves we first need to find the budget lines. Since the prices of balloons and candy are constant and the only thing changing is income it is fairly simple to find the budget lines:
If $M = \$50: 10 - 2B = C; (L_1)$
If $M = \$75: 25 - 2B = C; (L_2)$
If $M = \$100: 50 - 2B = C. (L_3)$

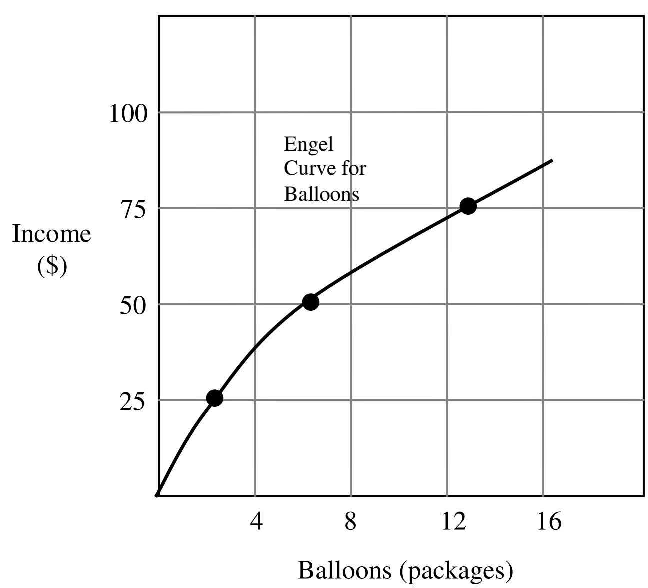
Next, we need to find the optimal bundles for each budget line. To do this we use the following equation: $\frac{MU_C}{MU_B} = \frac{B}{C} = \frac{5}{10} = \frac{P_C}{P_B} \Rightarrow 2B = C.$

Using the previous result you can solve for the optimal bundles at each budget line. The optimal bundles are as follows:
For $L_1: B = 2.5,\ C = 5.$
For $L_2: B = 6.25,\ C = 12.5.$
For $L_{31}: B = 12.5,\ C = 25.$

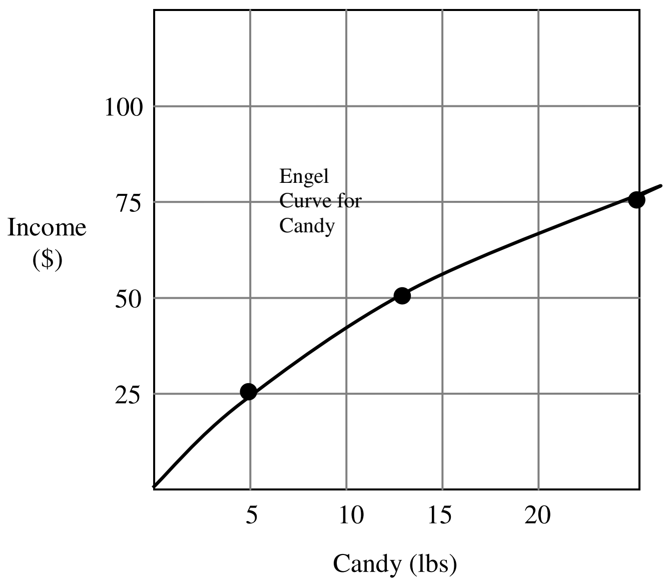
Now we have all of the information needed to plot the income-consumption curves and the Engel curves.



Candy (lbs)
20
15
10
5
Income-
Consumption
Curve
L_1
L_2
L_3
5
10
15
20
Balloons (packages)



Income ($)
100
75
50
25
Engel
Curve for
Balloons
4
8
12
16
Balloons (packages)



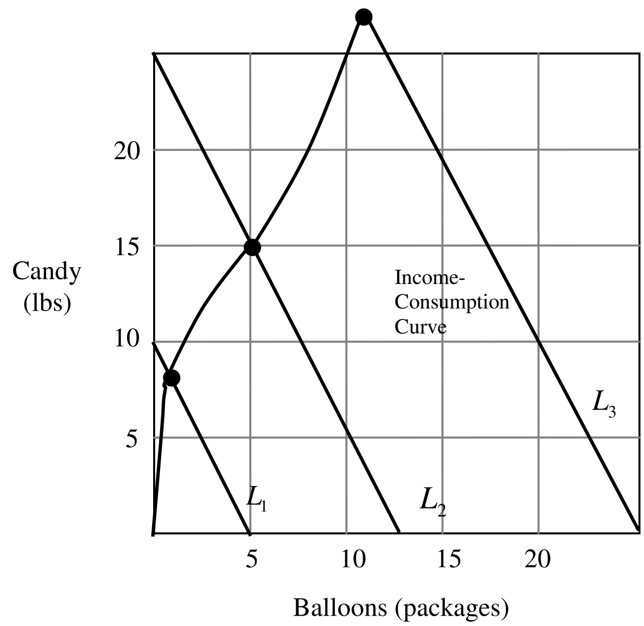
17. To plot the Income-consumption curves we first need to find the budget lines. Since the prices of balloons and candy are constant and the only thing changing is income it is fairly simple to find the budget lines:
If $M = \$50 : 10 - 2B = C; (L_1)$
If $M = \$75 : 25 - 2B = C; (L_2)$
If $M = \$100 : 50 - 2B = C \ (L_3)$

Next, we need to find the optimal bundles for each budget line. To do this we use the following equation: $\frac{MU_C}{MU_B} = \frac{2+B}{C} = \frac{5}{10} = \frac{P_C}{P_B} \Rightarrow 4 + 2B = C.$

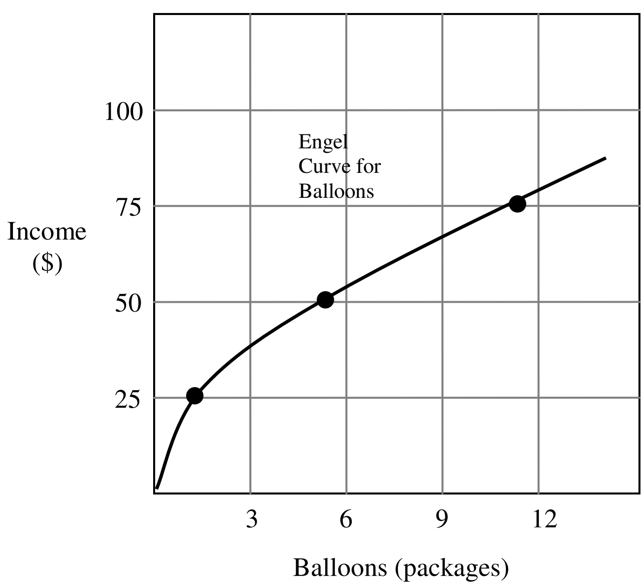
Using the previous result you can solve for the optimal bundles at each budget line.

The optimal bundles are as follows:
For $L_1 : B = 1.5,\ C = 7.$
For $L_2 : B = 5.25,\ C = 14.5.$
For $L_{31} : B = 11.5,\ C = 27.$

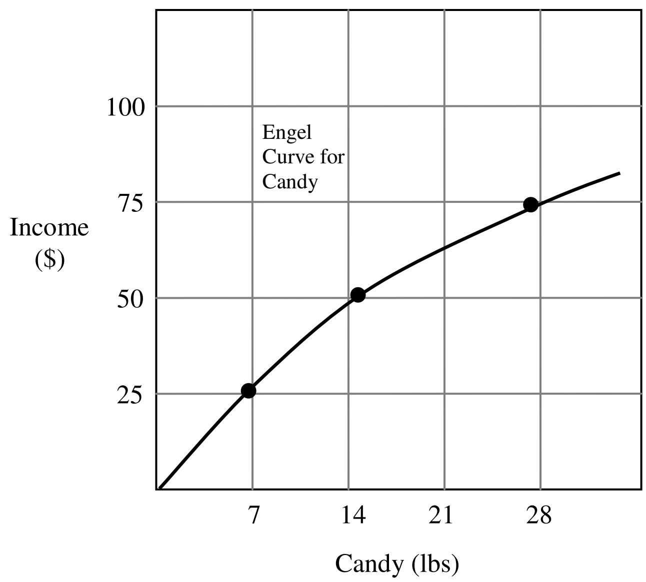
Now we have all of the information needed to plot the income-consumption curves and the Engel curves.



Candy (lbs)
20
15
10
5
Income-Consumption Curve
L_1
L_2
L_3
5
10
15
20
Balloons (packages)



Income ($)
100
75
50
25
Engel Curve for Balloons
3
6
9
12
Balloons (packages)



18. If the income-consumption curve bends backward (downward) toward the vertical (horizontal) axis when it passes a budget line's best bundle then you have an inferior good. If the I-C curve bends backward the good on the vertical axis is inferior. If the I-C curve bends downward the good on the horizontal axis is inferior.

Chapter 6

1. The difference between the substitution effect and income effect of a price change is the substitution effect represents a change in relative prices that causes a consumer to substitute one good for another. On the other hand, the income effect represents how price change affects a consumer's purchasing power. The effect of an uncompensated price change comes in two parts: (1) the effect of a compensated price change and (2) the effect of removing the compensation. In relation to the uncompensated price change the substitution effect represents part (1) and the income effect represents part (2).

2. To find the uncompensated effect of Holly's purchases of candy and balloons first use the tangency condition to solve for the B and C using a generic form of a budget constraint as follows:

   $M = P_C C + P_B B$ (Budget line)

   Tangency condition:

   $$MRS_{CB} = \frac{B}{C} = \frac{P_C}{P_B} \Leftrightarrow P_B B = P_C C$$

   Now use the previous result to solve for B and C:

   $$\frac{M}{2P_C} = C \;\&\; \frac{M}{2P_B} = B.$$

   So, with $M = \$50,\ P_C = \$5,\ P_B = \$10,$ she chooses $(C,B) = (5,2.5)$. If the price of balloons falls to \$5.00 she chooses $(C,B) = (5,5)$.This uncompensated price reduction raises Holly's balloon package purchases from 2.5 to 5 and leaves the amount of candy she buys unchanged.

   Next, to find the compensated effect we need to used the tangency condition and find the relationship between candy and balloons at their new prices.
   If $M = \$50,\ P_C = \$5,\ P_B = \$5,$ the relationship between candy and balloons is:

   $$C = B.$$

   Holly's best choice with a compensated price change also lies on the indifference curve that passes through the bundle $(C,B) = (5,2.5)$. Using the formula for her indifference curve $\left(B = \frac{U}{C}\right)$, the value of U that runs through the bundle $(C,B) = (5,2.5)$ is 12.5, which implies that Holly's formula for this indifference curve is:

   $$B = \frac{12.5}{C}$$

   A bundle can satisfy both the tangency condition formula and the indifference curve formula only if: $C = \frac{12.5}{C}$. This requires $C^2 = 12.5$, or $C \approx 3.54$. Using the tangency condition, we get that $B = 3.54$. So the compensated price effect shifts Holly from the bundle $(C,B) = (5,2.5)$ to the bundle $(C,B) = (3.54,3.54)$.

At the new prices, Holly requires only \$35.40 to buy the bundle $(C,B)=(3.54,3.54)$. Since her income is \$50, we could take away \$14.60 from Holly to compensate for the price cut.

To break up the uncompensated price change into substitution effects and income effects:
Note that the substitution effect is the same as the effect of the compensated price change. The income effect is what is known as the residual; it shifts Holly from the bundle $(C,B)=(5,2.5)$ to the bundle $(C,B)=(3.54,3.54)$.

3. To find the uncompensated effect of Holly's purchases of candy and balloons first use the tangency condition to solve for the B and C using a generic form of a budget constraint as follows:

$M = P_C C + P_B B$ (Budget line)

Tangency condition:

$$MRS_{CB} = \frac{2+B}{C} = \frac{P_C}{P_B} \Leftrightarrow P_B(2+B) = P_C C \Rightarrow C = \frac{P_B}{P_C}(2+B).$$

Now use the previous result and the generic budget line to solve for B and C:

$$M = \frac{P_B}{P_C}(2+B)P_C + BP_B \Leftrightarrow B = \frac{M}{P_B} - 2.$$

Now, for C:

$$C = \frac{P_B}{P_C}\left(2 + \left(\frac{M}{P_B} - 2\right)\right) \Leftrightarrow C = \frac{M}{P_C}.$$

So, with $M = \$50,\ P_C = \$5,\ P_B = \$10$, she chooses $(C,B)=(10,3)$. If the price of balloons falls to \$5.00 she chooses $(C,B)=(10,8)$.This uncompensated price reduction raises Holly's balloon package purchases from 3 to 8 and leaves the amount of candy she buys unchanged.

Next, to find the compensated effect we need to used the tangency condition and find the relationship between candy and balloons at their new prices.
If $M = \$50,\ P_C = \$5,\ P_B = \$5$, the relationship between candy and balloons is:

$$C = 2 + B.$$

Holly's best choice with a compensated price change also lies on the indifference curve that passes through the bundle $(C,B)=(10,3)$. Using the formula for her indifference curve $\left(B = \frac{U}{C} - 2\right)$, the value of U that runs through the bundle $(C,B)=(10,3)$ is 50, which implies that Holly's formula for this indifference curve is:

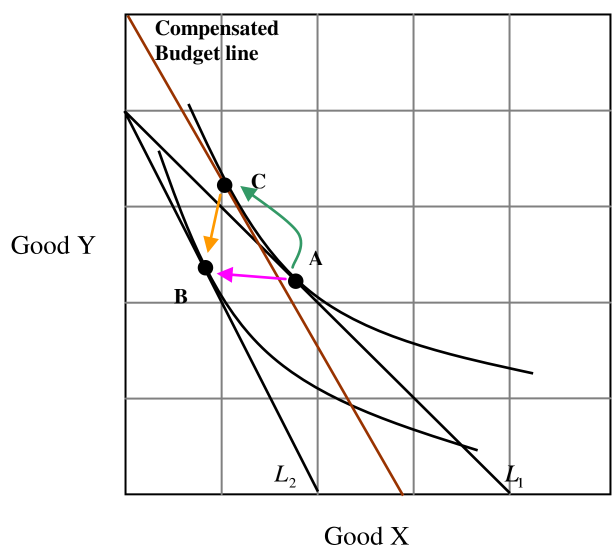
$$B = \frac{50}{C} - 2.$$

A bundle can satisfy both the tangency condition formula and the indifference curve formula only if: $B = \frac{50}{2+B} - 2 \Leftrightarrow 50 = B^2 + 4B + 4$. Using the quadratic formula yields $B \approx 5.07$. Next, using the tangency condition, we get that $C = 7.07$. So the compensated price effect shifts Holly from the bundle $(C, B) = (10,3)$ to the bundle $(C, B) = (5.07,7.07)$. (Note: you can check to see that both bundles are on the same indifference curve by plugging in each bundle into the utility function; both bundles should have the same utility).

At the new prices, Holly needs \$60.70 to buy the bundle $(C, B) = (5.07,7.07)$. Since her income is \$50, we would have to give her \$10.70 to compensate for the price cut.

To break up the uncompensated price change into substitution effects and income effects:
Note that the substitution effect is the same as the effect of the compensated price change. The income effect is what is known as the residual; it shifts Holly from the bundle $(C, B) = (10,3)$ to the bundle $(C, B) = (5.07,7.07)$.

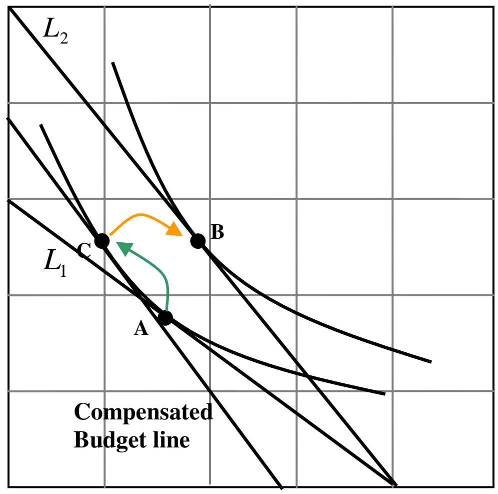
4.



Bundle A is the original bundle chosen before the price change. The arrow from A to C on the graph above shows the substitution effect of the change in the price of good X. Bundle B on the graph above is the bundle chosen after the price increase of good X. The arrow from C to B on the graph depicts the income effect of the price change; and bundle C represents the bundle chosen on the compensated budget line after the price change.

5.

Good Y



Good X

The reduction of the price of good Y causes the rotation of L_1 to L_2. Bundle A shown on the graph above is the bundle chosen before the price decrease of good Y. The arrow from A to C on the graph above shows the substitution effect of the change in the price of good Y. Bundle B on the graph above is the bundle chosen after the price decrease of good Y. The arrow from C to B on the graph depicts the income effect of the price decrease; and bundle C represents the bundle chosen on the compensated budget line after the price change putting the consumer back on their original indifference curve.

6. The income effect represents a change in a consumer's purchasing power. When the price of a normal good increases the purchasing power of the consumer is negatively affected because it the consumer would require a positive compensation to get them back to the original indifference curve. If the price of an inferior good increases the good become a more scare good making more like a normal good but cheaper in price. Thus increasing the price of an inferior good has the result of a positive income effect.

7. A Giffen good is a good that's quantity sold increases as its price increases. The law of demand says that for a normal good as the price of the good increases the quantity sold decreases. So, a Giffen good would violate the law of demand.

8. First we must use the budget line and the tangency condition to solve for optimal values of candy and balloons.
   $C = 10 - 2B$ (Budget line)
   Tangency condition:
   $$MRS_{CB} = \frac{B}{C} = \frac{1}{2} = \frac{P_C}{P_B} \Leftrightarrow 2B = C.$$
   Solving for B and C we get $B = 2.5$ & $C = 5$.
   Next, use the utility function in its functional form to solve for U with the optimal bundle:

$$\frac{U}{C} = B \Leftrightarrow \frac{U}{5} = 2.5 \Rightarrow U = 12.5$$

If Holly can't get any balloons, $B = 0.$ To place her on the same indifference curve as before we must pick a value of C for which $0 = \frac{12.5}{C}.$ However, this is not possible because Holly's overall utility is dependent on having some of both goods, and under the restrictions of her current utility function she cannot be compensated.

9. First we must use the budget line and the tangency condition to solve for optimal values of candy and balloons.
   $C = 10 - 2B$ (Budget line)
   Tangency condition:
   $$MRS_{CB} = \frac{2+B}{C} = \frac{1}{2} = \frac{P_C}{P_B} \Leftrightarrow 4 + 2B = C.$$
   Solving for B and C we get $B = 1.5 \;\&\; C = 7.$

   Next, use the utility function in its functional form to solve for U with the optimal bundle:
   $$\frac{U}{C} - 2 = B \Leftrightarrow \frac{U}{7} - 2 = 1.5 \Rightarrow U = 24.5$$

   Holly's indifference curve formula through this bundle is:
   $$\frac{24.5}{C} - 2 = B.$$

   If the store does not have balloons, $B = 0.$ Therefore, to place Holly on the same indifference curve, we must pick the value of B for which $0 = \frac{24.5}{C} - 2.$ Solving for C, we get $C = 12.25.$ To buy 12.25lbs of candy Holly would need \$61.25, so the store would have to pay her \$11.25 to compensate for not having balloons in stock. This is Holly's compensation variation.

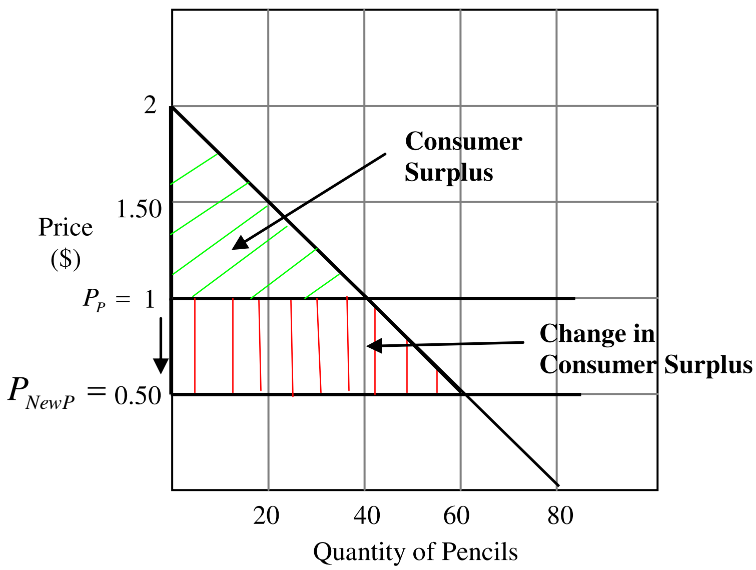
10. Holly's consumer surplus is shown on the graph below (shaded diagonally).

   To calculate Holly's consumer surplus, find the area of the shaded triangle:
   $$CS = \frac{1}{2}(\$2 - \$1)(40 - 0) = 20.$$

   If the price of a pencil falls to 50 cents, then Holly's consumer surplus will now include the trapezoid shaded vertically in addition to the diagonally shaded triangle to make one big triangle. Calculating the change in Holly's consumer surplus can be done in several ways one such way goes as follows:

Take the area of the triangle after the price change and subtract it by the area of the triangle before the price change.

$$\Delta CS = \left[\frac{1}{2}(\$2 - \$0.50)(60 - 0)\right] - \left[\frac{1}{2}(\$2 - \$1)(40 - 0)\right] = 25.$$



11. The horizontally shaded triangle represents Holly's consumer surplus before the price change, when the price of paint was $6. Here the consumer surplus is: $CS = \frac{1}{2}(10 - 6)(3.2 - 0) = 6.4$

    The number 3.2 is found by evaluating the quantity sold at $6 using the demand function.

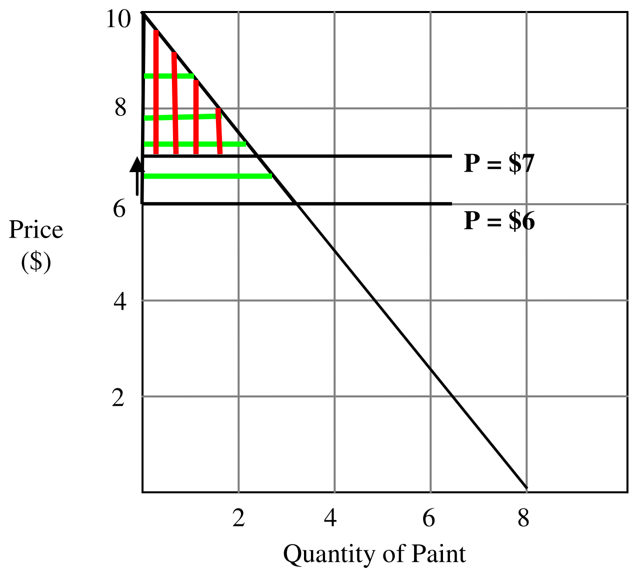
    If the price of paint increases to $7 then Holly's consumer surplus decreases, as is depicted on the graph above by the entire shaded triangle. You can calculate the change in the consumer surplus as follows:

    Take the area of the triangle before the price change and subtract it by the area of the triangle after the price change.

    $$\Delta CS = \left[\frac{1}{2}(\$10 - \$6)(3.2 - 0)\right] - \left[\frac{1}{2}(\$10 - \$7)(2.4 - 0)\right] = 2.8$$

    The number 2.4 is found by evaluating the quantity sold at $7 using the demand function.

.



12. A cost-of-living index measures the relative cost of achieves a fixed standard of living in different situations.
    Laspeyres index tells us how much more income is necessary to reach the consumer's original level of well-being by buying the consumer's original consumption bundle. By doing this Laspeyres index neglects new and cheaper ways to attain the original level of well-being, thus overstating the amount of income that is actually required.

13. An increase in the wage rate could increase the amount of labor supplied if the increase in the wage rate increases the cost of leisure to a point where the laborer is not willing to substitute leisure for less labor supplied.

    An increase in the wage rate could decrease the amount of labor supplied if the increase in the wage rate increases the purchasing power of a laborer sufficiently enough to offset the increase in the cost of leisure to the point where leisure time rises at the expense of labor supplied.

    Both of these situations are possible with a backward bending supply curve.

14. The uncompensated (Marshallian) demand curve differs from the compensated (Hicksian) demand curve in what they hold constant and what they allow to vary when describing the relationship between price and the amount consumed. Uncompensated demand curves hold consumer's income fixed and they allow well-being to vary. Compensated demand curves hold a consumer's well-being fixed and allow the income to vary.

    The compensated and uncompensated demand curves would be the same if a good was neither normal, nor inferior. They differ when a good is normal or inferior.

15. To find the equation of the compensated demand curve first take the formula for the tangency condition and the price of balloons equal to 10:

$$MRS_{CB} = \frac{B}{C} = \frac{P_C}{10} \Leftrightarrow CP_C = 10B \Leftrightarrow B = \frac{CP_C}{10}.$$

Next, rewrite the utility function as follows using the bundle given:

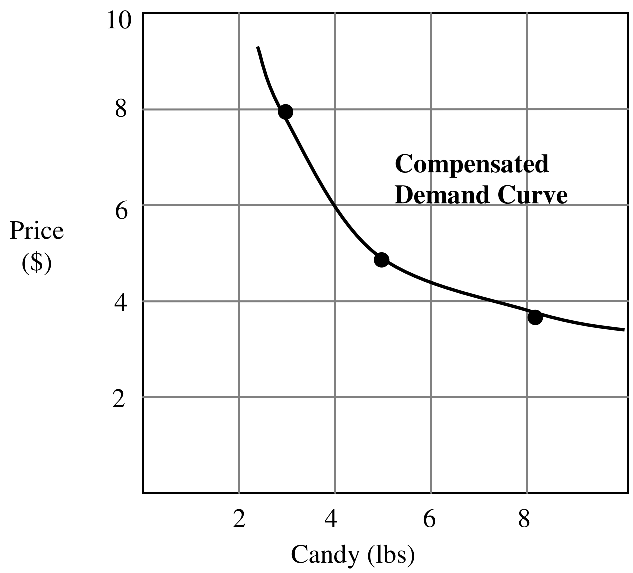
$$U(5.2.5) = 5 \times 2.5 = 12.5$$

$$\Rightarrow B = \frac{12.5}{C}.$$

Now set the tangency condition formula equal to the indifference curve formula equal to each other and solve for C:

$$\frac{12.5}{C} = \frac{CP_C}{10} \Leftrightarrow \sqrt{\frac{125}{P_C}} = C.$$

This is the compensated demand curve.



16. To find the equation of the compensated demand curve first take the formula for the tangency condition and the price of balloons equal to 10:

$$MRS_{CB} = \frac{2+B}{C} = \frac{P_C}{10} \Leftrightarrow CP_C = 20 + 10B \Leftrightarrow B = \frac{CP_C - 20}{10}.$$

Next, rewrite the utility function as follows using the bundle given:

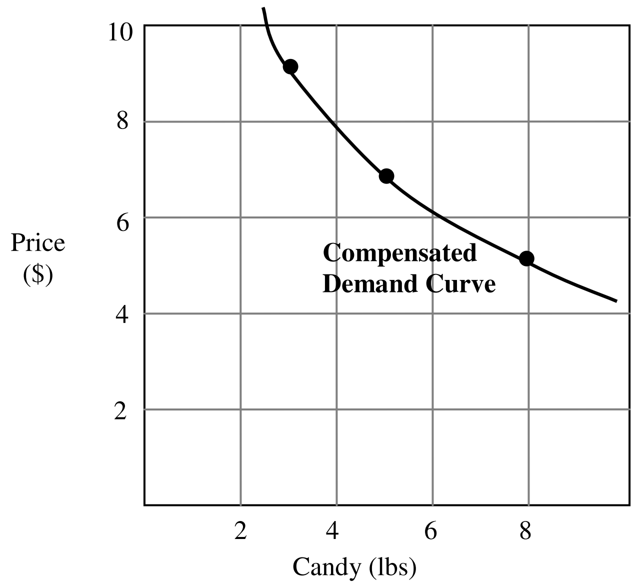
$$U(7{,}1.5) = 2(7) + (7 \times 1.5) = 24.5$$

$$\Rightarrow B = \frac{24.5}{C} - 2.$$

Now set the tangency condition formula equal to the indifference curve formula equal to each other and solve for C:

$$\frac{24.5}{C} - 2 = \frac{CP_C - 20}{10} \Leftrightarrow CP_C - 20 = \frac{245}{C} - 20 \Leftrightarrow C^2 P_C = 245 \Rightarrow C = \sqrt{\frac{245}{P_C}}.$$

This is the compensated demand curve.


10
8
6
4
2
Price
($)
Compensated
Demand Curve
2
4
6
8
Candy (lbs)

Chapter 7

1. Use the graph to see which methods are inefficient.

Production Method	Units of Labor	Output	Efficient?
A	1	48	Yes
B	2	124	Yes
C	2	112	No
D	3	205	No
E	3	216	Yes
F	4	312	Yes
G	4	295	No

Production methods that are inefficient are characterized by lower levels of output per unit of labor (or any other input).

2. A firm's efficient production frontier is represents only the most efficient sets among all the possible sets, whereas the production possibilities curve represents all the possible sets including the most efficient sets.

   Firms should aim to achieve a point on their efficient production set because any point on that line represents the most efficient method of production given the number of inputs.

3. To find how many cups of lemonade Giselle can produce daily with one worker, use the production function provided, and evaluate it where L = 1:

$$Q = F(1) = -2(1)^3 + 20(1)^3 + 30(1)$$
$$= -2 + 20 + 30 = 48 \text{ cups of lemonade}$$

   If another worker is hired, then L = 2:

$$Q = F(2) = -2(2)^3 + 20(2)^3 + 30(2)$$
$$= -16 + 160 + 60 \ = 204 \text{ cups of lemonade}$$

   These answers show that at low levels of inputs the marginal product of labor is increasing at an increasing rate.

4. To find how many cups of lemonade Giselle can produce daily with one worker, use the production function provided, and evaluate it where L = 1:

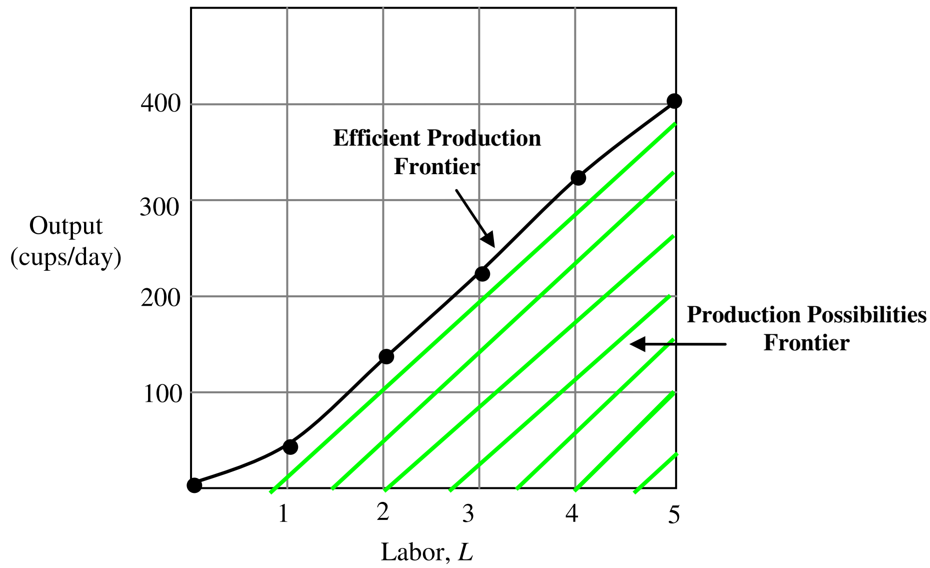
$$Q = F(1) = -3(1)^3 + 25(1)^2 + 20(1)$$
$$= -3 + 25 + 20 = 42 \text{ cups of lemonade}$$

   If another worker is hired then L = 2:

$$Q = F(2) = -3(2)^3 + 25(2)^2 + 20(2)$$
$$= -24 + 100 + 40 \ = 116 \text{ cups of lemonade}$$

These answers show that at low levels of inputs the marginal productivity of labor is increasing at an increasing rate.

5.



$$Q = F(L) = -2(L)^3 + 20(L)^2 + 30L$$
if L = 0 $\Rightarrow Q = 0$
if L = 1 $\Rightarrow Q = F(1) = -2(1)^3 + 20(1)^2 + 30(1) = -2 + 20 + 30 = 48$
if L = 2 $\Rightarrow Q = F(2) = -2(2)^3 + 20(2)^2 + 30(2) = -16 + 80 + 60 = 124$
if L = 3 $\Rightarrow Q = F(3) = -2(3)^3 + 20(3)^2 + 30(3) = -54 + 180 + 90 = 216$
if L = 4 $\Rightarrow Q = F(4) = -2(4)^3 + 20(4)^2 + 30(4) = -128 + 320 + 120 = 312$
if L = 5 $\Rightarrow Q = F(5) = -2(5)^3 + 20(5)^2 + 30(5) = -250 + 500 + 150 = 400$

6.

Number of Laborers	Output (cups/day)	MP_L	AP_L
0	0	-	-
1	48	48	48
2	124	76	62
3	216	92	72
4	312	96	78
5	400	88	80
6	468	68	78

Looking at the chart above, Giselle should hire 5 laborers. If Giselle should hire more than 5 laborers the workers $MP_L \; \pi \; AP_L$, thus it will not be worth it to hire one more worker.

If you know calculus you could use the fact that the MP_L curves crosses the AP_L curve at its highest point, and any point after that the AP_L curve will be greater than the MP_L curve.

Find the AP_L curve: $\frac{F(L)}{L} = \frac{-2L^3 + 20L^2 + 30L}{L}$

$$AP_L = \frac{F(L)}{L} = -2L^2 + 20L + 30$$

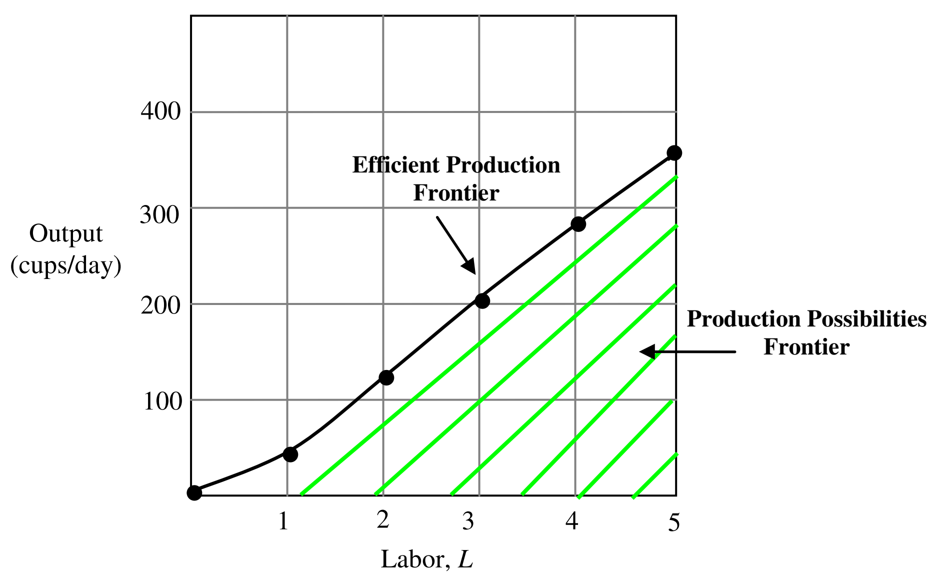
Next take the derivative of the AP_L and set it equal to 0, then solve for L:

$$AP_L{}' = -4L + 20 = 0$$
$$L = 5$$

$$AP_L = \frac{F(5)}{5} = -2(5)^2 + 20(5) + 30 = 80 \text{ cups per day}$$

This gives the highest point on the AP_L curve.

7.



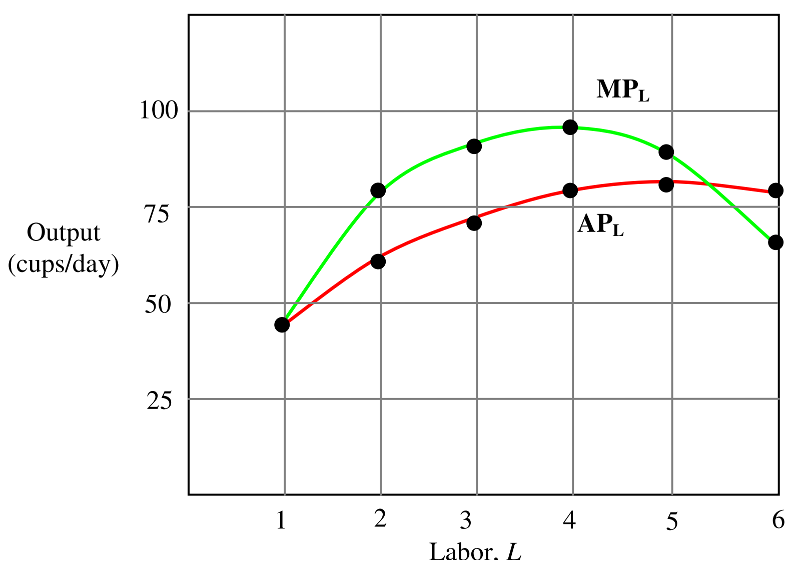
$Q = F(L) = -3L^2 + 2L^2 + 20L$	MP_L	AP_L
if L = 0: $Q = 0$		
if L = 1: $F(1) = -3(1)^2 + 25(1)^2 + 20(1) = 42$	42	42
if L = 2: $F(2) = -3(2)^2 + 25(2)^2 + 20(2) = 116$	74	58
if L = 3: $F(3) = -3(3)^2 + 25(3)^2 + 20(3) = 204$	88	68
if L = 4: $F(4) = -3(4)^2 + 25(4)^2 + 20(4) = 288$	84	72
if L = 5: $F(5) = -3(5)^2 + 25(5)^2 + 20(5) = 350$	62	70

8. An isoquant identifies all the input combinations that efficiently produce a given amount of output. Isoquants cannot slope upwards because an upward sloping isoquant would have combinations with one having more of every input than the other. The productive inputs principle implies that this can't happen.

9. Notice that as the number of workers increases the MP_L increases to a certain point , and then begins to decrease.

Units of Labor	Output	MP_L	AP_L
0	0	0	0
1	48	48	48
2	124	76	62
3	216	92	72
4	312	96	78
5	400	88	80
6	468	68	78

10. The average product of labor and the marginal product of labor are related in the way they slope. The AP slopes upward when it is below the MP curve and downward when it is above the MP curve.



11.

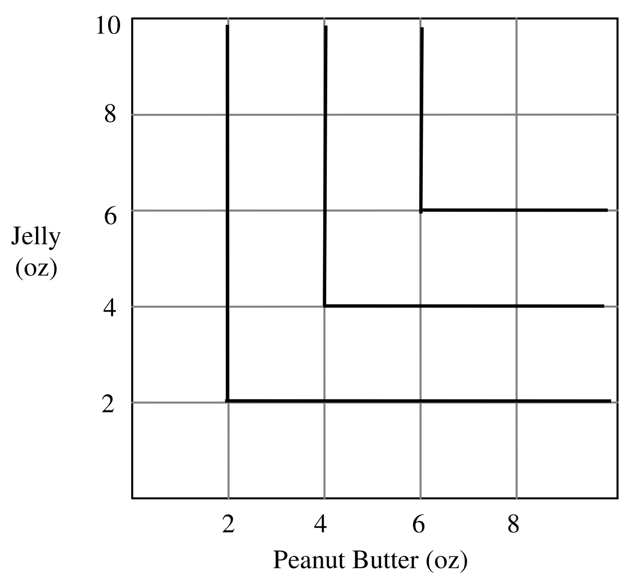
Units of Labor	Units of Capital	Output
1	1	48.00
1	2	57.08
2	1	80.73
2	2	96.00
2	3	106.24
3	2	130.12
3	3	136.30

Looking at output levels associated with either an increase in a unit of labor, or a unit of capital we see that labor is more productive than capital at Pucker Up.

12. Calculate $MRTS_{LK} = \dfrac{MP_L}{MP_K} = \dfrac{\dfrac{36K^{1/4}}{L^{1/4}}}{\dfrac{36L^{3/4}}{K^{3/4}}} = \dfrac{36K^{1/4}}{L^{1/4}} \times \dfrac{K^{3/4}}{36L^{3/4}} = \dfrac{K}{L}$

Yes, the isoquant would exhibit declining MRTS in this case because as we increase labor and decrease capital the MRTS declines.

13. This family of isoquants demonstrates that jelly and peanut butter are perfect complements. The graph shows for example, at 2 oz. of jelly the firm cannot be made better by having more peanut butte while jelly is at 2 oz.



14. $Q = F(L,K) = 48L^{3/4}K^{1/4} \Rightarrow \alpha + \beta = 3/4 + 1/4 = 1$ Constant returns to scale

$Q = F(L,K) = 48L^{1/2}K^{1/4} \Rightarrow \alpha + \beta = 1/2 + 1/4 = 3/4 < 1$ Decreasing returns to scale

Since we are using Cobb-Douglas production functions we can add the exponents $\alpha + \beta$ to check whether the function yields increasing, decreasing, or constant returns to scale.

15. Giselle's *MRTS* remains unchanged. This type of productivity improvement is called a factor-neutral technical change, which is characterized by having no affect on the *MRTS* at any output combination. It only changes the output level associated with each of the firm's isoquants.

Chapter 8

1. The key characteristic that distinguishes an avoidable fixed costs from a sunk fixed cost is that with the former a firm doesn't incur the cost (or can recuperate it) if it produces not output. A sunk fixed cost is incurred even if the firm decides not to operate.

2. First, solve for the number of hours of labor needed to produce Q cups of lemonade:

$$Q = 4\sqrt{L} \Leftrightarrow \frac{Q}{4} = \sqrt{L} \text{ (square both sides)}$$

$$\Rightarrow \frac{Q^2}{16} = L$$

Next, multiply the previous result by the wage rate to get the variable cost function,

$$VC(Q) = 10\frac{Q^2}{4} = \frac{5Q^2}{2}$$

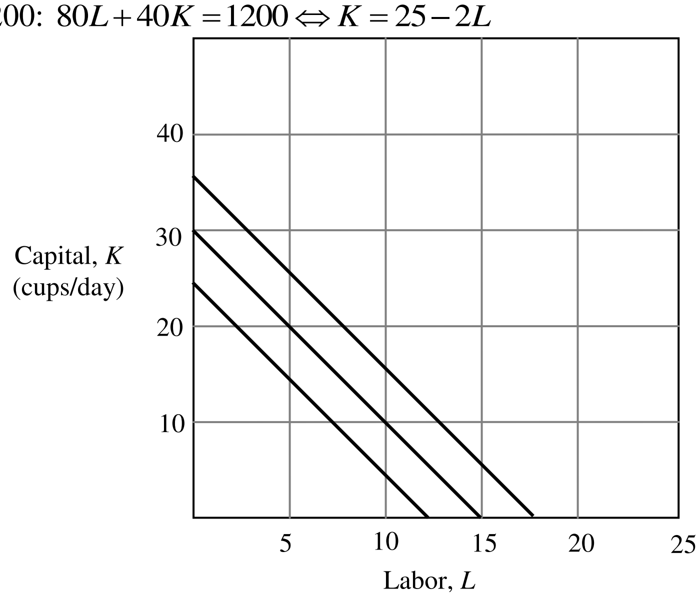
The short run cost function is therefore $C(Q) = 75 + \frac{5Q^2}{2}$.

3. First, solve for the number of hours of labor needed to produce Q cups of lemonade:

$$Q = L^2 \Rightarrow \sqrt{Q} = L \text{ (take the square root of both sides)}$$

Next, multiply the wage rate by the previous result to get the variable cost function $VC(Q) = 10\sqrt{Q}$. The short-run cost function is therefore $C(Q) = 75 + 10\sqrt{Q}$.

4. Using the fact that wages are \$80 per day and a unit of capital costs \$40 per day and the formula $wL + rK = C$ deriving the isocost lines for C =1200, C =1400, and C = 1000 is straight forward:
If C = 1200: $80L + 40K = 1200 \Leftrightarrow K = 30 - 2L$
If C = 1400: $80L + 40K = 1400 \Leftrightarrow K = 35 - 2L$
If C = 1200: $80L + 40K = 1200 \Leftrightarrow K = 25 - 2L$



5. We know the $MRTS_{LK}$ for the Cobb-Douglas production function $Q = F(L,K) = 15L^{\alpha}K^{\beta}$ is $MRTS_{LK} = \left(\frac{\alpha}{\beta}\right)\left(\frac{K}{L}\right)$ which has a declining $MRTS_{LK}$.
Now set the $MRTS_{LK}$ equal to the input price ratio: $\left(\frac{\alpha}{\beta}\right)\left(\frac{K}{L}\right) = \left(\frac{w}{r}\right)$ where $\alpha = \frac{1}{2}$, $\beta = \frac{1}{2}$, w = \$80 per day, and r = \$40.

$$\left(\frac{\frac{1}{2}}{\frac{1}{2}}\right)\left(\frac{K}{L}\right) = \frac{80}{40}$$
$$\frac{K}{L} = 2$$

The tangency condition holds at the point on the 150 cup per day isoquant where the capital-labor ratio equals 2. When Giselle uses L units of labor and $2L$ units of capital, the output is:

$$Q = F(L, 2L) = 15L^{\frac{1}{2}}(2L)^{\frac{1}{2}}$$
$$Q = 15\sqrt{2}L$$

Producing 150 cups of lemonade requires:

$$150 = 15\sqrt{2}L$$
$$7.071 \approx L \Rightarrow L = 7 \text{ workers}$$

Because we rounded to 7 workers, the amount of capital (K) needed is $2L$.

2(7) = 14 units of capital

So Giselle's total cost for one day is $\$1120\left[= 7(80) + 14(40)\right]$.

6. We know that the $MRTS_{LK}$ for the Cobb-Douglas production function $Q = F(L,K) = 12L^{\alpha}K^{\beta}$ is $MRTS_{LK} = \left(\frac{\alpha}{\beta}\right)\left(\frac{K}{L}\right)$ which has a declining $MRTS_{LK}$. Now set the $MRTS_{LK}$ equal to the input price ratio: $\left(\frac{\alpha}{\beta}\right)\left(\frac{K}{L}\right) = \left(\frac{w}{r}\right)$ where $\alpha = \frac{3}{4}$, $\beta = \frac{1}{4}$, w = \$80 per day, and r = \$40.

$$\left(\frac{\frac{3}{4}}{\frac{1}{4}}\right)\left(\frac{K}{L}\right) = 2$$
$$3K = 2L$$
$$K = \tfrac{2}{3}L$$

The tangency condition holds at the point on the 120 cups of lemonade isoquant at which the capital-labor ratio equals 4. When Giselle uses L units of labor and $\frac{2}{3}L$ units of capital, output is:

$$Q = F\left(L, \tfrac{2}{3}L\right) = 12L^{\frac{3}{4}}\left(\tfrac{2}{3}L\right)^{\frac{1}{4}} = 12\left(\sqrt[4]{\tfrac{2}{3}}\right)L$$

Therefore, producing 130 cups of lemonade per day requires

$$130 = 12\left(\sqrt[4]{2/3}\right)L$$
$$L \approx 11.989$$
$$L = 12$$

$$K = \tfrac{2}{3}L$$
$$K = \tfrac{2}{3}(12)$$
$$K = 8$$

Giselle's least cost input combination uses 12 workers and 8 units of capital. Her total cost is: $8(40) + 12(80) = \$1280$

7. In problem 5 we found that to produce Q cups of lemonade Giselle needs the amount of labor L that solves the formula: $Q = 15\sqrt{2}L$ and she needs 2 times the amount of capital. Thus Giselle needs $\dfrac{Q}{15\sqrt{2}}$ workers and $\dfrac{2Q}{15\sqrt{2}}$ units of capital. The cost of producing Q units is therefore,

$$\begin{aligned} C(Q) &= 80\left(\frac{Q}{15\sqrt{2}}\right) + 40\left(\frac{2Q}{15\sqrt{2}}\right) \\ &= \frac{16Q}{3\sqrt{2}} + \frac{16Q}{3\sqrt{2}} \\ &= \frac{32Q}{3\sqrt{2}}. \end{aligned}$$

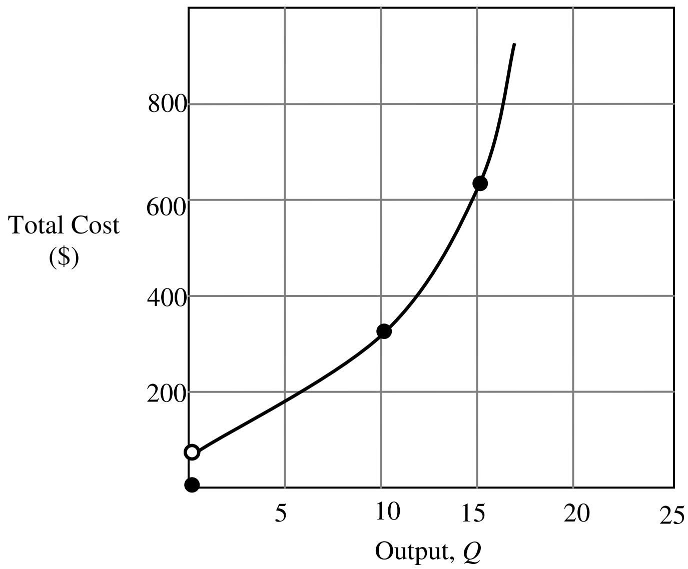
Similarly, in problem (6) Giselle's formula for Q cups of lemonade, and L amounts of labor: $Q = 12\left(\sqrt[4]{2/3}\right)L$ and she needs $2/3$ the amount of capital. Thus, Giselle needs $\dfrac{Q}{12\left(\sqrt[4]{2/3}\right)}$ workers and $\left(\dfrac{2}{3}\right)\dfrac{Q}{12\left(\sqrt[4]{2/3}\right)} = \dfrac{Q}{18\left(\sqrt[4]{2/3}\right)}$ units of capital.

The cost of producing Q units is therefore,

$$C(Q) = 80\left(\frac{Q}{12\left(\sqrt[4]{2/3}\right)}\right) + 40\left(\frac{Q}{18\left(\sqrt[4]{2/3}\right)}\right)$$
$$C(Q) = \frac{20Q}{3\left(\sqrt[4]{2/3}\right)} + \frac{20Q}{9\left(\sqrt[4]{2/3}\right)}$$

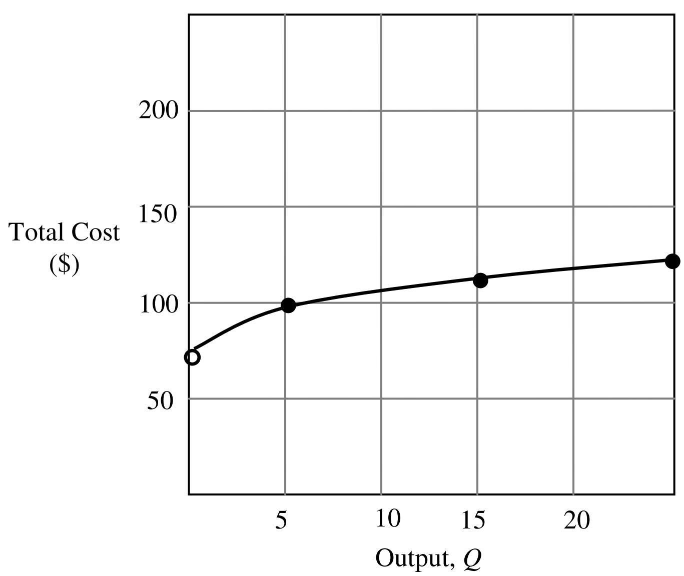
8. The relationship between Giselle's labor input and her output of lemonade is the same as was worked out in problem 2. So her cost function is

$$C(Q) = \begin{cases} 0 & \text{if } \; Q = 0 \\ 75 + \tfrac{5}{2}Q^2 & \text{if } \; Q > 0 \end{cases}$$



9. The relationship between Giselle's labor input and her output of lemonade is the same as was worked out in problem 3. So her cost function is

$$C(Q) = \begin{cases} 0 & \text{if } \quad Q = 0 \\ 75 + 10\sqrt{Q} & \text{if } \quad Q > 0 \end{cases}$$



10. A firm that is producing at an efficient level of production is producing an output with the lowest possible average cost. No, a firm does not always have to produce at this level of output. However, if a firm wants to produce a large amount of output at the lowest possible cost, they should try to divide it up among a number of firms so that each may produce at their efficient scale of production.

11. We know that with a least-cost plan that assigns a positive amount of output to each stand, marginal cost must be the same at both stands. Thus Giselle needs to divide production between her two stands so that their marginal cost are equal. Doing this means choosing Q_1 and Q_1 so that MC_1=MC_2. Since total output equals 225 cups of lemonade, we know $Q_2 = 225 - Q_1$ so we can express MC_2 as follows: $MC_2 = 4(225 - Q_1)$.

    Next, to find how much each stand will produce, set MC_1=MC_2:

$$\begin{aligned} 8Q_1 &= 4(225 - Q_1) \\ 8Q_1 &= 900 - 4Q_1 \\ 12Q_1 &= 900 \\ Q_1 &= 75 \\ Q_2 &= 225 - 75 \\ Q_2 &= 150 \end{aligned}$$

    Therefore, Giselle must produce 75 cups of lemonade in stand 1 and 150 cups in stand 2. Her total cost of production will be:

$$C(Q) = 4(75)^2 + 8(150)^2 = \$202{,}500$$

12. Similarly to problem 11, Giselle must divide the production between her two stands so that both stands have the same marginal cost. Thus, Giselle must choose Q_1 and Q_2 such that $MC_1 = MC_2$. Since total output equals 350 cups of lemonade, we know $Q_2 = 350 - Q_1$; so we can express MC_2 as follows:

$$MC_2 = 4(350 - Q_1)$$

    To find how much each stand will produce, set $MC_1 = MC_2$:

$$\begin{aligned} 10Q_1 &= 4(350 - Q_1) \\ 14Q_1 &= 1400 \\ Q_1 &= 100 \end{aligned}$$

    Now for Q_2:

$$\begin{aligned} Q_2 &= 350 - Q_1 \\ &= 350 - 100 \\ Q_2 &= 250 \end{aligned}$$

    Therefore, Giselle must produce 100 cups of lemonade in stand 1 and 250 cups in stand 2. Her total cost of production will be:

$$C(Q) = 5(100)^2 + 2(250)^2 = \$175{,}000$$

13. The fixed cost for the firm above is \$100. This number might represent a sunk cost, like the cost to rent a building. A fixed cost will not depend on how much output is produced.

To identify firms variable cost *V(Q)* in the function above, look at the parts of the equation that are dependent on *Q*. IT follows that the $V(Q) = 8Q + 2Q^2$.

To find the average cost (*AC)* use the fact that $AC(Q) = \frac{C}{Q}$. In this firm's case it is:

$$AC(Q) = \frac{100 + 8Q + 2Q^2}{Q}$$

$$AC(Q) = \frac{100}{Q} + 8 + 2Q$$

To find the *AVC* and *AFC* use the following fact:

$$AC = \frac{C}{Q} = \frac{VC + FC}{Q} = \frac{VC}{Q} + \frac{FC}{Q} = AVC + AFC$$

Now, $AC = \frac{100 + 8Q + 2Q^2}{Q} = \frac{100}{Q} + \frac{8Q + 2Q^2}{Q}$. Thus, $AFC = \frac{100}{Q}$ and $AVC = 8 + 2Q$.

14. If Giselle's capital is fixed at 8 units, to produce 130 cups of lemonade the amount of labor *L* that solves the formula is:

$$Q = 12L^{3/4}(8)^{1/4}$$

which means that,

$$L^{3/4} = \frac{Q}{12\sqrt[4]{8}}$$

$$L = \left(\frac{Q}{12(8)^{1/4}}\right)^{4/3}$$

$$L = \frac{Q^{4/3}}{(12)^{4/3}(8)^{1/3}}$$

$$L = \frac{Q^{4/3}}{2\sqrt[3]{(12)^4}}$$

So Giselle's short-run cost function is

$$C_{SR}^{130}(Q) = 40(8) + 80\left(\frac{Q^{4/3}}{2(12)^{4/3}}\right)$$

$$C_{SR}^{130}(Q) = 320 + 40\left(\frac{Q}{12}\right)^{4/3}$$

Giselle's long-run cost function is the same as the answer to problem 7.

$$C(Q) = 20Q\left(\frac{1}{3\left(\frac{2}{3}\right)^{1/4}} + \frac{1}{9\left(\frac{2}{3}\right)^{1/4}}\right)$$

Observe that their short-run and long-run costs are equal when Q = 130.

$$C_{SR}^{130}(130) = C_{LR}^{130}(130) = \$1{,}278.83$$

15. If Giselle's capital is fixed at 10 units, to produce Q cups of lemonade the amount of labor that solves the formula is:

$$Q = 15\sqrt{L}\sqrt{10}$$

$$Q \Rightarrow L = \frac{Q^2}{\left(15\sqrt{10}\right)^2}$$

$$L = \frac{Q^2}{2250}$$

So her short-run cost function is,

$$C_{SR}^{150}(Q) = 40(10) + 80\left(\frac{Q^2}{2250}\right)$$

$$C_{SR}^{150} = 400 + \frac{8Q^2}{225}$$

Giselle's long-run cost function is, (as was found in problem 7).

$$C_{LR}(Q) = \frac{32Q}{3\sqrt{2}}$$

Note that Giselle's short-run and long-run costs are equal when Q=150. (Since $C_{SR}^{150}(150) = C_{LR}^{150}(150)$.

16. $TC(Q) = 250Q + 5Q^2$

If Q increases to 2Q:

$TC(2Q) = 250(2Q) + 5(2Q)^2$

$TC(2Q) = 500Q + 20Q^2$.

Compare this to $2C(Q)$:

$$2TC(Q) = 2\left(250Q + 5Q^2\right)$$

$$2TC(Q) = 500Q + 20Q^2.$$

$$TC(2Q) = 500Q + 2Q^2 > 2TC(Q) = 500Q + 10Q^2.$$

Now divide both sides by 2Q: $250 + 10Q > 250 + 5Q$.

This result shows that the average cost rises as the firm produces more, demonstrating diseconomies of scale.

Chapter 9

1. We can find the inverse demand function $P(Q)$ by solving

$$Q = 80 - 2P$$
$$P = 40 - \frac{Q}{2}$$

for *P*, which gives us

$$P(Q) = 40 - \frac{Q}{2}$$

To determine the price at which $Q^d = 40$, solve for *P* such that

$$P = 40 - \frac{40}{2}$$
$$P = \$20$$

Megan should price each shirt at \$20.
If $Q^d = 50$, solve for *P* such that,

$$P = 40 - \frac{50}{2}$$
$$P = \$15$$

Megan should price each shirt at \$15.

2. We can find the inverse demand function $P(Q)$ by solving

$$Q = 120 - 3P$$
$$P = 40 - \frac{Q}{3}$$

for *P*, which gives us

$$P(Q) = 40 - \frac{Q}{3}$$

To determine the price at which $Q^d = 60$, solve for *P* such that

$$P = 40 - \frac{60}{3}$$
$$P = \$20$$

Megan should price each shirt at \$20.
If $Q^d = 75$, solve for *P* such that,

$$P = 40 - \frac{75}{3}$$
$$P = \$15$$

Megan should price each shirt at \$15.

3. A price-taking firm cannot affect the market price for a good by any means. A price-taking firm cannot change the price by selling their good at a higher or lower price than the market price. Therefore, no matter how many units of a good a price-taking firm sells they will always have the same price leading to the characteristic horizontal demand curve.

4. Use the quantity rule. Thus, Megan's best positive sales quantity solves the formula $P = MC$, or

$$6 = 2 + \frac{Q}{25}$$
$$Q = 100$$

Now we must check the shut-down rule, by calculating the profit from producing 100 T-shirts.

$$\pi = 6(100) - \left[2(100) + \tfrac{(100)^2}{50}\right]$$
$$= 600 - 400$$
$$\pi = \$200$$

Megan should go ahead and produce 100 T-shirts. If Megan also has an avoidable cost of $150 per day her profit at Q = 100 would be $50 and she should still continue to produce.

5. Use the quantity rule. Thus, Megan's best positive sales quantity solves the formula $P = MC$, or

$$6.60 = 3 + \frac{Q}{30}$$
$$Q = 108$$

Now we must check the shut-down rule, by calculating the profit from producing 108 T-shirts.

$$\pi = 6.60(108) - \left[3(108) + \tfrac{(108)^2}{60}\right]$$
$$= 712.80 - 518.40$$
$$\pi = \$194.40$$

Megan should go ahead and produce 108 T-shirts. If Megan also has an avoidable cost of $200 per day her profit at Q = 108 would be negative, and the shut-down rule would tell Megan to stop producing T-shirts all together.

6. The best positive sales quantity, Q, is found when the price P is set equal to the marginal cost, so that

$$P = 2 + \frac{Q}{25}$$

Solving for Q, we find that

$$Q = 25P - 50$$

If Megan has no avoidable fixed cost, $AC_{\min} = \$2$. Note: $C(Q) = 2Q + Q^2/50$,

so $AC(Q) = 2 + \frac{Q}{50}$. Since this is an increasing function we know that \$2 is the minimum. So using the shut-down rule, Megan's supply function is

$$S(P) = \begin{cases} 25P - 50 & \textit{if} \;\; P \geq 2 \\ 0 & \textit{if} \;\; P \leq 2 \end{cases}$$

When we add an avoidable fixed cost of \$150 per day, this does not change MR or MC, but it does change when Megan wants to stay in business. We need to determine the new level of $AC_{\min}$. This is done by setting $AC = MC$ to determine the new efficient scale of production.

$$MC = 2 + \frac{Q}{25} = \frac{150}{Q} + 2 + \frac{Q}{50} = AC$$

Solving for Q, we find $Q \approx 86.60$. Substituting this quantity into the equation for average cost shows us that $AC_{\min} = \frac{150}{86.60} + 4 + \frac{86.60}{50} = \$7.46$

So Megan's supply function is now

$$S(P) = \begin{cases} 25P - 50 & \textit{if} \;\; P \geq 7.46 \\ 0 & \textit{if} \;\; P \leq 7.46 \end{cases}$$

7. The best positive sales quantity, Q, is found when the price P is set equal to the marginal cost, so that

$$P = 3 + \frac{Q}{30}$$

Solving for Q, we find that

$$Q = 30P - 90$$

If Megan has no avoidable fixed cost, $AC_{\min} = \$3$. Note: $C(Q) = 3Q + \frac{Q^2}{60}$,

so $AC(Q) = 3 + \frac{Q}{60}$. Since this is an increasing function we know that \$3 is the minimum. So using the shut-down rule, Megan's supply function is

$$S(P) = \begin{cases} 30P - 90 & \textit{if} \;\; P \geq 3 \\ 0 & \textit{if} \;\; P \leq 3 \end{cases}$$

When we add an avoidable fixed cost of \$200 per day, this does not change MR or MC, but it does change when Megan wants to stay in business. We need to determine the new level of $AC_{\min}$. This is done by setting $AC = MC$ to determine the new efficient scales of production.

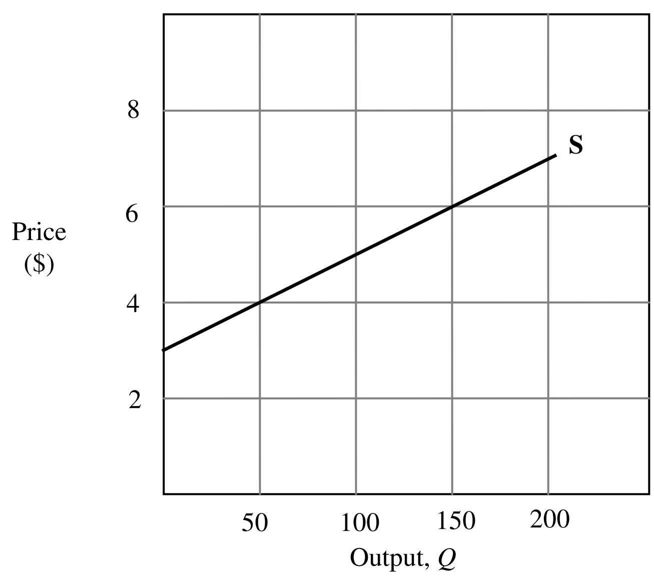
$$MC = 3 + \frac{Q}{30} = \frac{200}{Q} + 3 + \frac{Q}{60} = AC$$

Solving for Q, we find $Q \approx 109.50$. Substituting this quantity into the equation for average cost shows us that $AC_{\min} = \frac{200}{109.50} + 3 + \frac{109.50}{60} = \$6.65$

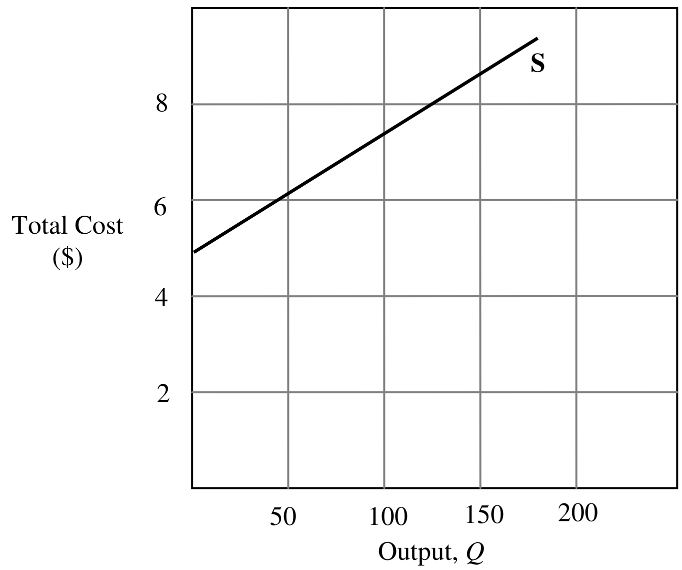
So Megan's supply function is now

$$S(P) = \begin{cases} 30P - 90 & \text{if } P \geq 6.65 \\ 0 & \text{if } P \leq 6.65 \end{cases}$$

8. The minimum price at which Megan will choose to sell is \$3.



9. The minimum price at which Megan will choose to sell is \$5.



10. An increase in the price of a major input of a firm's supply function will shift the firm's function upward; raising that firm's cost per unit by the same amount as the increase in the price of the input. An increase in an avoidable fixed cost shifts a firms average cost curve and its resulting supply curve, but it does not change the marginal cost curve, so the firm's supply is unchanged if it does not shut down.

11. Let's begin with Megan's long-run supply function first. If the price is greater than 150, we have $P > MC$ at every output level. Because they make a positive profit on every unit they sell, they will want to sell an infinite amount. If P < 150, they will want to sell $Q = 0$. If $P = 150$, the firm will be willing to supply any amount, since they earn zero profit no matter how much they sell.

    For Megan's short-run supply curve, we must apply the quantity rule. The quantity at which $P = MC$ solves the formula $P = Q$. Thus, the most profitable quantity given the price P is $Q = P$. At this quantity Megan's revenue is $P \times P = P^2$ and her avoidable costs are $P^2/2$ and she will produce in the short run as long as $P > 0$. The short run supply function is therefore $S_{SR}(P) = P$.

12. Let's begin with Megan's long-run supply function first. If the price is greater than 200, we have $P > MC$ at every output level. Because they make a positive profit on every unit they sell, they will want to sell an infinite amount. If P < 200, they will want to sell $Q = 0$. If $P = 200$, the firm will be willing to supply any amount, since they earn zero profit no matter how much they sell.

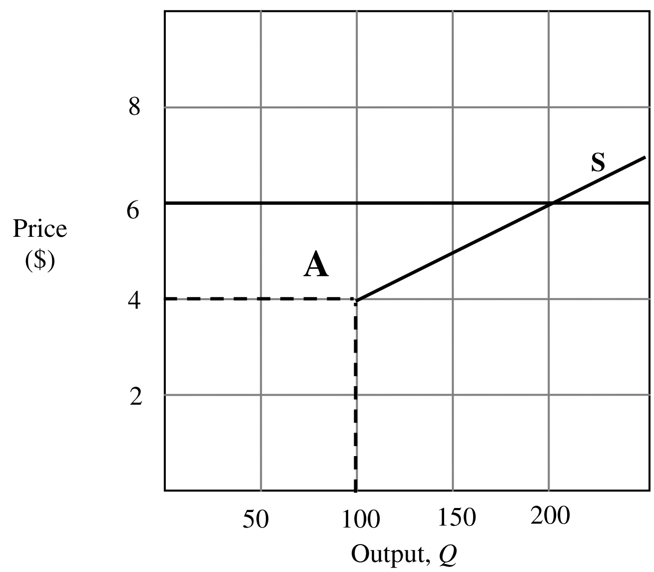
    For Megan's short-run supply curve, we must apply the quantity rule. The quantity at which $P = MC$ solves the formula $P = Q$. Thus, the most profitable quantity given the price P is $Q = P$. At this quantity Megan's revenue is $P \times P = P^2$ and her avoidable costs are $P^2/2$ and she will produce in the short run as long as $P > 0$. The short run supply function is therefore $S_{SR}(P) = P$.

13. Before the avoidable cost this firm's producer surplus is:

$$PS = \frac{1}{2}[(6-2)(200-0)] = 400.$$

With an avoidable fixed cost this firm's producer surplus is the trapezoidal region A, or equivalently:

$$PS = \frac{1}{2}[(6-4)(200-100)] + [(6-4)(100-0)] = 300.$$



14. First, find the inverse supply function:

$$S(P) = Q = 50P - 150$$

$$\frac{Q}{50} + 3 = P$$

From the inverse supply function we see that the minimum price Megan would be willing to produce at is \$3. Now, we need to find how much Megan would produce at a price of \$7:

Set $P = MC$,

$$7 = \frac{Q}{50} + 3$$

$$Q = 200.$$

So the producer's surplus is:

$$PS = \frac{1}{2}\left[(7-3)(200-0)\right] = 400$$

To find Megan's producer's surplus after the $200 non-transferable permit we need to find her new minimum price:

To do so, use the inverse supply function which is equal to the marginal cost.

$$\frac{Q}{50} + 3 = P = MC$$

Next, take the producer's surplus before the non-transferable permit, which was 400 and subtract the $200 cost to get the new producer's surplus of $200.

15. First, start by applying the quantity rule to find the sales quantities for both the shirt and the hat, where $P = MC$.

$$(1) \quad 18 = 4 + 2Q_S - Q_H$$

and,

$$(2) \quad 10 = 2 + 2Q_H - Q_S$$

Now with equations (1) and (2) we can solve for Q_S and Q_H. This can be done in several ways but we will proceed as follows:
Rewrite (1) and (2).

$$(1) \quad -14 + 2Q_S = Q_H$$

$$(2) \quad -8 + 2Q_H = Q_S$$

Substitute (1) into (2) and solve for Q_S.

$$-8 + 2(-14 + 2Q_S) = Q_S$$

$$-36 = -3Q_S$$

$$12 = Q_S$$

Solve for Q_H.

$$-14 + 2(12) = Q_H$$

$$Q_H = 10$$

Megan's profit is:

$$\pi = (R - C)$$

$$\pi = \left[(12\times 18) + (10\times 10)\right] - \left[(4\times 12) + 12^2 - (12\times 10)\right] - \left[(2\times 10) + 10^2 - (12\times 10)\right]$$

$$\pi = \$244$$

Applying the shut down rule, we have to compare this profit not only to Megan's profit if she would shut-down her operation, but also, her profit if she would shut-down the production of either of her products, and only would produce one product.

If Megan is not producing her T-shirts such that $Q_S = 0$, her cost function becomes $C_H(Q_H) = 2Q_H + Q_H^2$ and $MC_H = 2 + 2Q_H$. The best quantity of hats is $Q_H = 4$, which yields \$16 profit which is less than what Megan makes if she produces both products.

This was found by setting *P* = *MC*:

$$10 = 2 + 2Q_H$$
$$Q_H = 4$$

Megan's profit is,

$$\pi = (4 \times 10) - [(2 \times 4) + 4^2]$$
$$\pi = \$16$$

If Megan stops producing the hats so that $Q_B = 0$, her cost function becomes $C_S(Q_S) = 4Q_S + Q_S^2$ and $MC_S = 4 + 2Q_S$. Set *P* = *MC*:

$$18 = 4 + 2Q_S$$
$$Q_S = 7$$

Megan's profit is,

$$\pi = [(7 \times 18) - ((4 \times 7) + 7^2)]$$
$$\pi = \$49$$

Again, this is less than Megan would make if she produced both the T-shirts and the hats, so Megan should produce the profit-maximizing sales quantities of $Q_S = 12$ and $Q_H = 10$.

Chapter 10

1. Compounding refers to the payment of interest on a loan balance that includes interest earned in the past. Compounding causes the loan balance to grow faster as time passes. It is important to factor compounding interest when you are making a saving decision because you should realize that you won't see immediate large returns on your investment, but they will increase over time. If you are about to make a borrowing decision it is important to factor compounding because as a borrower you should understand that you will have a larger loan balance as more and more time passes.

2. If the R = *5%*:

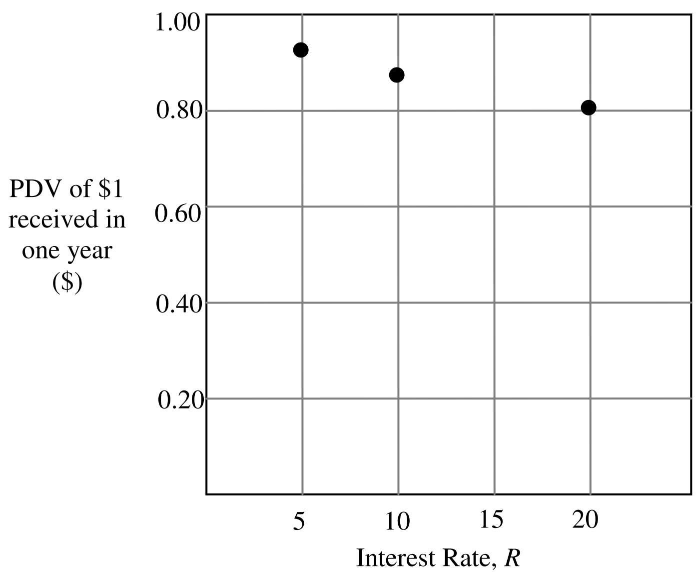
$$PDV = \frac{1}{(1+.05)^1} \approx 95.24 cents$$

If the R = *10%*:

$$PDV = \frac{1}{(1+.10)^1} \approx 90.90 cents$$

If the R = *20%*:

$$PDV = \frac{1}{(1+.20)^1} \approx 83.33 cents$$



The graph shows an inverse relationship between the present discounted value and the interest rate. For instance, as the interest rate increases, the *PDV* of the future dollar is less.

This makes sense because as the interest rate goes higher any initial deposit or investment accumulates a larger balance, so you don't have to deposit as much to get to your target amount.

3. To calculate the *PVD* of $100 received in 5 years at the various interest rates shown above, we need to identify some variables from the formula:

$$PVD = \frac{FutureValue(\$F)}{(1+R)^T}$$

Notice that, *T*, tells use in years how long it will take to received the future value *F,* which is $100, and *R,* is the interest rate which will vary in this problem:

If the *R = 5%*:

$$PDV = \frac{\$100}{(1+.05)^5} \approx \$78.35$$

If the *R = 10%*:

$$PDV = \frac{\$100}{(1+.10)^5} \approx \$62.09$$

If the *R = 20%*:

$$PDV = \frac{\$100}{(1+.20)^5} \approx \$40.19$$

4. Notice that the value of *R* is fixed in this problem, at 5%. The value of *F* is $1, and the value of *T* will vary between 5, 10, and 20 years. The PDV can be calculated as follows:

If the *T = 5 years:*

$$PDV = \frac{\$1}{(1+.05)^5} \approx 78.35 cents$$

If the *T = 10 years:*

$$PDV = \frac{\$1}{(1+.05)^{10}} \approx 61.39 cents$$

If the *T = 20 years:*

$$PDV = \frac{\$1}{(1+.05)^{20}} \approx 37.69 cents$$

5. To find out how much you would owe your friend in today's dollars, use the formula for finding the present discounted value of a stream:

$$PDV = F_0 + \frac{F_1}{(1+R)} + \frac{F_2}{(1+R)^2} + \Lambda + \frac{F_T}{(1+R)^T}$$

Therefore,

$$PDV = 0 + \frac{200}{(1+.05)} + \frac{250}{(1+.05)^2} + \frac{300}{(1+.05)^3} + \frac{400}{(1+.05)^4}$$

$$PVD = 0 + 190.48 + 226.75 + 259.15 + 329.08$$

$$PVD = \$1005.46$$

So in today's dollars you will have to pay your friend \$1005.46 to borrow \$1000.

6. To find out how much you would owe for your car in today's dollars, use the formula for finding the present discounted value of a constant stream:

$$PDV = \frac{F}{R}\left(1 - \frac{1}{(1+R)^T}\right)$$

Notice that *R = 7%*, and $F_0 = 0$.

$$PDV = \frac{F}{R}\left(1 - \frac{1}{(1+R)^T}\right)$$

$$PDV = \frac{5000}{.07}\left(1 - \frac{1}{(1+.07)^6}\right)$$

$$PDV = \$23{,}832.70$$

Compared to the unadjusted payment of \$30,000 the *PDV* of \$23,832.70 is much less, and from a car buyers view-point much more desirable, because you end up paying \$6167.30 less than the unadjusted payment.

7. Option (1) requires no calculations; it is simply \$25,000 in today's dollars.

To figure out how much option (2) will cost in today's dollars we must perform the *PDV* calculation for a constant stream:

$$PDV = \frac{F}{R}\left(1 - \frac{1}{(1+R)^T}\right)$$

$$PDV = \frac{9000}{.08}\left(1 - \frac{1}{(1+.08)^3}\right)$$

$$PDV = \$23{,}193.87$$

To calculate how much option (3) will cost in today's dollars we must perform the *PDV* calculation for a constant stream:

$$PDV = \frac{6000}{.08}\left(1 - \frac{1}{(1+.08)^5}\right)$$

$$PDV = \$23{,}956.26$$

Therefore, with an interest rate of 8% option (2) is the lowest price option measuring in today's dollars.

8. Use the formula for finding the *PDV* of promised bond payments.

$$PDV = \frac{C}{R}\left(1 - \frac{1}{(1+R)^M}\right) + \frac{V}{(1+R)^M}$$

M represents the 10 year bond, *C* represents the \$50 coupon, and *V* represents the \$5000 face value.

According to the formula, the *PDV* of promised payments at a 5% interest rate is therefore,

$$PDV = \frac{50}{.05}\left(1 - \frac{1}{(1+.05)^{10}}\right) + \frac{5000}{(1+.05)^{10}}$$
$$PDV = \$3{,}455.65$$

If R = *10%:*

$$PDV = \frac{50}{.10}\left(1 - \frac{1}{(1+.10)^{10}}\right) + \frac{5000}{(1+.10)^{10}}$$
$$PDV = \$2{,}234.94$$

If R = *15%:*

$$PDV = \frac{50}{.15}\left(1 - \frac{1}{(1+.15)^{10}}\right) + \frac{5000}{(1+.15)^{10}}$$
$$PDV = \$1{,}486.86$$

If the coupon was removed the formula above would look like:

$$PDV = \frac{V}{(1+R)^M}$$

At an interest rate of 5%, 10%, and 15%, the *PDV*'s would be \$3069.57, \$1927.72, and \$1235.92 respectively. Thus each *PDV* would decrease without the \$50 coupon.

9. To find the real interest rate, use the formula:

$$R^{real} = \frac{R^{nominal} - INFL}{1 + INFL}$$

$$R^{real} = \frac{.065 - .02}{1 + .02} \approx 4.4\%$$

If the rate of inflation grew to 3.5%, then the real interest rate would be:

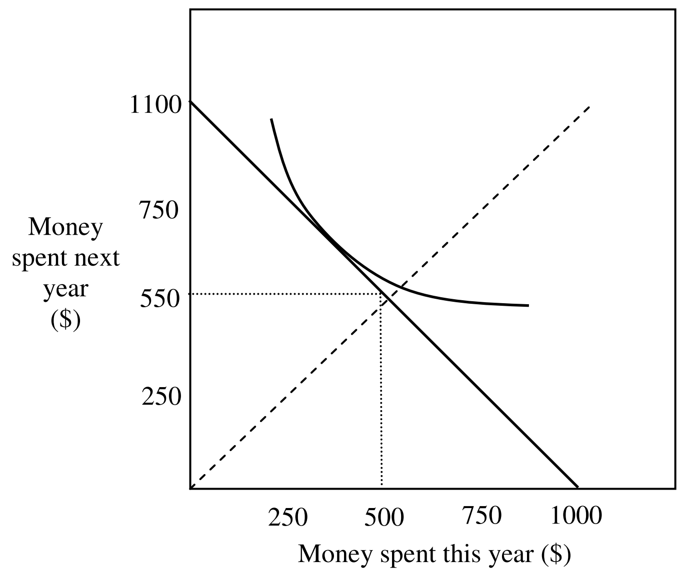
$$R^{real} = \frac{.065 - .035}{1 + .035} \approx 2.9\%$$

As the rate of inflation grows the real interest rate decreases.

10. To find the nominal interest rate, we need to rearrange the formula $R^{real} = \dfrac{R^{nominal} - INFL}{1 + INFL}$, to look like $R^{nominal} = INFL + R^{real}(1 + INFL)$. Now we may proceed by substituting values for inflation and the real interest rate into the formula.

$$R^{nominal} = .035 + .04(1 + .035)$$
$$R^{nominal} = 7.64\%$$

11. Draw the 45° line on the graph. In relation to the 45° line Brian's preference is above the line according to his indifference curve. This tells us that Brian prefers to spend more money next year than this year in order to maximize his preferences.



12. An increase in the interest rate could increase or decrease a consumer's savings rate. If the interest rate increased, a consumer that was planning on saving a target amount of money would find that their purchasing power has increased. If the income effect of this increase in the interest rate is larger than the substitution effect a consumer in this situation could find him/her-self spending more and saving less.
    On the other hand, if the interest rate was increased a consumer's savings rate could increase if the substitution effect was greater than the income effect. In a savings example, the cost of saving has decreased and the cost of not saving has increased.

13. Start by identifying bundles that satisfy the tangency condition. The slope of Brian's indifference curve is $-\dfrac{F_0}{F_1}$ (his *MRS* times negative one); and the slope of his budget line is $-(1+R)\left(\dfrac{1}{1}\right)$. Brian's best choice is where the slope of his indifference curve is

equal (tangent) to his budget line, which is $-\frac{F_0}{F_1} = -(1+R)$, or

equivalently $F_1 = \frac{F_0}{(1+R)}$. This tangency condition informs us that Brian consumes $(1+R)$ times as much food this year as next year.

The formula for Brian's budget line is $F_0 + F_1(1+R) = 2400$. To find the bundle to satisfy the tangency condition and the budget line formula, substitute for F_1 in the budget line formula using the tangency condition formula.

$$F_0 + F_1(1+R) = 2400$$
$$F_0 + \frac{F_0}{(1+R)}(1+R) = 2400$$
$$2F_0 = 2400$$
$$F_0 = 1200$$

So, this year Brian will spend \$1200 and save \$1200; next year he will spend $\frac{1200}{(1+R)}$.
Because the interest rate is 5%, Brian consumes 1200 pounds of food this year and 1142.85 pounds next year.

If Brian makes \$2400 the first year and \$1200 the next year, then Brian's new budget line is as follows:

$$F_0 + F_1(1+R) = 2400 + \frac{1200}{(1+R)}$$
$$F_0 + \frac{F_0}{(1+R)}(1+R) = 2400 + \frac{1200}{(1+R)}$$
$$F_0 = 1200 + \frac{600}{(1+R)}$$

So, this year Brian will spend $1200 + \frac{600}{(1+R)}$ and saves $2400 - 1200 + \frac{600}{(1+R)}$;next year he will spend $\frac{1200}{(1+R)} + \frac{600}{(1+R)^2}$. Because the interest rate is 5%, Brian consumes 1771.43 pounds of food this year, and 1687.07 pounds of food next year.

The formula for Brian's savings can be written as *S = 1200*, because when Brian makes \$2400 in the first year and nothing the second year, his savings do not depend on the interest rate.

The formula for Brian's savings for the situation in which he makes money in both years is the following:

$$S(R) = 2400 - 1200 + \frac{600}{(1+R)}$$

$$S(R) = 600\left(2 + \frac{1}{(1+R)}\right)$$

In this instance we see that Brian's savings rate depends on the interest rate.

14. Start by identifying bundles that satisfy the tangency condition. The slope of Brian's indifference curve is $-\frac{F_0}{F_1}$ (his *MRS* times negative one); and the slope of his budget line is $-(1+R)\left(\frac{1}{1}\right)$. Brian's best choice is where the slope of his indifference curve is equal (tangent) to his budget line, which is $-\frac{F_0}{F_1} = -(1+R)$, or equivalently $F_1 = \frac{F_0}{(1+R)}$. This tangency condition informs us that Brian consumes $(1+R)$ times as much food this year as next year.

The formula for Brian's budget line is $F_0 + F_1(1+R) = 0 + \frac{2400}{(1+R)}$. To find the bundle to satisfy the tangency condition and the budget line formula, substitute for F_1 in the budget line formula using the tangency condition formula.

$$F_0 + F_1(1+R) = \frac{2400}{(1+R)}$$

$$F_0 + \frac{F_0}{(1+R)}(1+R) = \frac{2400}{(1+R)}$$

$$2F_0 = \frac{2400}{(1+R)}$$

$$F_0 = \frac{1200}{(1+R)}$$

So, this year Brian will spend $\frac{1200}{(1+R)}$ and save $1200 - \frac{1200}{(1+R)}$; next year he will spend $\frac{1200}{(1+R)^2}$. Because the interest rate is 5%, Brian consumes 1142.85 pounds of food this year and 1088.44 pounds next year.

Brian's savings function is:

$$S(R) = 1200\left(1 - \frac{1}{(1+R)}\right)$$

15. Start by identifying bundles that satisfy the tangency condition. The slope of Brian's indifference curve is $-\frac{F_0}{2F_1}$ (his *MRS* times negative one); and the slope of his budget line is $-(1+R)\left(\frac{1}{1}\right)$. Brian's best choice is where the slope of his indifference curve is equal (tangent) to his budget line, which is $-\frac{F_0}{2F_1} = -(1+R)$, or equivalently $F_1 = \frac{F_0}{2(1+R)}$. This tangency condition informs us that Brian consumes $2(1+R)$ times as much food this year as next year.

    The formula for Brian's budget line is $F_0 + F_1(1+R) = 2000 + \frac{1000}{(1+R)}$. To find the bundle to satisfy the tangency condition and the budget line formula, substitute for F_1 in the budget line formula using the tangency condition formula.

$$F_0 + F_1(1+R) = 2000 + \frac{1000}{(1+R)}$$

$$F_0 + \frac{F_0}{2(1+R)}(1+R) = 2000 + \frac{1000}{(1+R)}$$

$$\frac{3}{2}F_0 = 1000\left(2 + \frac{1}{(1+R)}\right)$$

$$F_0 = \left(\frac{2000}{3}\right)\left(2 + \frac{1}{(1+R)}\right)$$

    So, this year Brian will spend $\left(\frac{2000}{3}\right)\left(2 + \frac{1}{(1+R)}\right)$ and save $2000 - \left(\frac{2000}{3}\right)\left(2 + \frac{1}{(1+R)}\right)$; next year he will spend $\frac{2000}{3(1+R)} + \frac{1000}{6(1+R)^2}$. Because the interest rate is 5%, Brian consumes 1968.25 pounds of food this year and 786.09 pounds next year.

    Brian's savings function is:

$$S(R) = 2000\left(1 - \left(\frac{1}{3}\right)\left(2 + \frac{1}{(1+R)}\right)\right)$$

16. To calculate the (NPV) of each project use the formula:

$$NPV = NCF_0 + \frac{NCF_1}{(1+R)} + \frac{NCF_2}{(1+R)^2} + \Lambda + \frac{NCF_T}{(1+R)^T}$$

For project A:

$$NPV = -15000 + \frac{5000}{(1+.10)} + \frac{5000}{(1+.10)^2} + \frac{5000}{(1+.10)^3} + \frac{5000}{(1+.10)^4}$$

$$NPV \approx \$849.32$$

For project B:

$$NPV = -10000 + \frac{4350}{(1+.10)} + \frac{4350}{(1+.10)^2} + \frac{4350}{(1+.10)^3}$$

$$NPV \approx \$817.81$$

To calculate the internal rate of return (IRR) we must use either a financial calculator or a spreadsheet because the investment lasts more than two periods. The IRR for project A is 12.59%. The IRR for project B is 14.59%.

The payback period for project A is greater than 3 years but less than 4 years.

The payback period for project B is greater than 2 years but less than 3 years.

The payback periods can be found by figuring out at what T value the investment will recoup the initial investment:

$$NCF_0 \leq \frac{NCF_1}{(1+R)} + \frac{NCF_2}{(1+R)^2} + \Lambda + \frac{NCF_T}{(1+R)^T}$$

Therefore, at an interest rate of 10% project A is the better investment because of the higher *NPV*. Project B has a higher IRR and slightly faster payback period, but that is not enough to make it the better project.

If the interest rate was to increase to 12%, project B would become the better investment with a higher *NPV* than project A, at \$447.97 and \$186.75 respectively.

Chapter 11

1. To calculate your expected payoff, set up the payoff's as follows:

$$EP = (0.05)(\$1) + (0.05)(-\$1)$$

$$EP = \$0$$

$0 is your expected payoff. Flipping a coin 10 times will not change your total expected payoff.

2. To calculate the expected cost (EC) of repairs, set up the expected payoff equation:

$$EC = (0.7)(\$150) + (0.2)(\$600) + (0.10)(\$1{,}450)$$

$$EC = \$370$$

The expected cost of repairs is $370.

If the real probabilities are 60%, 25%, and 15% your expected cost of repairs is,

$$EC = (0.60)(\$150) + (0.25)(\$600) + (0.15)(\$1{,}450)$$

$$EC = \$457.50$$

The true expected cost of repairs is $457.50.

3. To derive the constant expected consumption line $B_L(\Pi, B_W)$, set up the expected consumption equation with EC = $400, and proceed to solve for B_L in terms of Π and B_W.

$$EC = \Pi\ B_W + (1-\Pi)B_L$$

$$400 = \Pi B_W + (1-\Pi)B_L$$

Solving for B_L:

$$B_L = \frac{400}{(1-\Pi)} - \frac{\Pi B_W}{(1-\Pi)}$$

If $\Pi = \frac{1}{2}$:

$$B_L = \frac{400}{(1-\frac{1}{2})} - \frac{\frac{1}{2}B_W}{(1-\frac{1}{2})}$$

$$B_L = 800 - B_W$$

The slope of the line is negative one.

If $\Pi = \frac{1}{3}$:

$$B_L = \frac{400}{(1-\frac{1}{2})} - \frac{\frac{1}{2}B_W}{(1-\frac{1}{2})}$$

$$B_L = 600 - \frac{1}{2}B_W$$

The slope of the line is negative one-half.

4. Michael's expected consumption is, $\left(\frac{3}{4}\right)(100)+\left(\frac{1}{4}\right)(36)=\$84$. To calculate the certainty equivalent, find the level of guaranteed consumption, *B*, that places Michael on the same *IC* curve as the risky bundle.

$$\frac{3}{4}\left(\sqrt{100}\right)+\frac{1}{4}\left(\sqrt{36}\right)=\frac{3}{4}\left(\sqrt{B}\right)+\frac{1}{4}\left(\sqrt{B}\right)$$
$$9=\sqrt{B}$$
$$B=81$$

So the certainty equivalent is 81. Since $84-81=3$, the risk premium is 3.

5. Michael's expected consumption is, $\left(\frac{3}{4}\right)(144)+\left(\frac{1}{4}\right)(36)=\$117$. To calculate the certainty equivalent, find the level of guaranteed consumption, *B*, that places Michael on the same *IC* curve as the risky bundle.

$$\frac{3}{4}\left(\sqrt{144}\right)+\frac{1}{4}\left(\sqrt{36}\right)=\frac{3}{4}\left(\sqrt{B}\right)+\frac{1}{4}\left(\sqrt{B}\right)$$
$$10.5=\sqrt{B}$$
$$B=110.25$$

So the certainty equivalent is \$110.25. Since $117-110.25=6.75$, the risk premium is \$6.75.

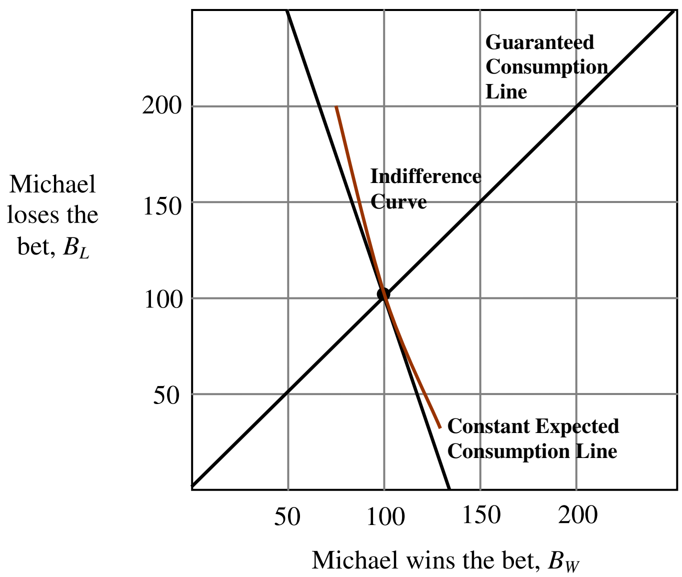
6. Michael's expected utility function is,

$$U\left(B_W,B_L\right)=\frac{3}{4}\sqrt{B_W}+\frac{1}{4}\sqrt{B_L}$$

Using this formula, plug-in the point $(B_W,B_L)=(100,100)$ to find that $U\left(B_W,B_L\right)=10$. So points on the indifference curve through the point $(B_W,B_L)=(100,100)$ satisfy the formula $10=\frac{3}{4}\sqrt{B_W}+\frac{1}{4}\sqrt{B_L}$. Now, solve for B_L.

$$10=\frac{3}{4}\sqrt{B_W}+\frac{1}{4}\sqrt{B_L}$$
$$10=\frac{1}{4}\left(3\sqrt{B_W}+\sqrt{B_L}\right)$$
$$40-3\sqrt{B_W}=\sqrt{B_L}$$
$$B_L=\left(40-3\sqrt{B_W}\right)^2$$

The constant expected consumption line that runs through the point $(B_W,B_L)=(100,100)$ satisfies the formula $\frac{3}{4}B_W+\frac{1}{4}B_L=100$, which can be rewritten as $B_L=400-3B_W$. Notice that the indifference curve is tangent to the constant expected consumption line at the point $(B_W,B_L)=(100,100)$, and above all other points on the line. Michael is therefore risk averse.



7. Michael's expected utility function is,

$$U(B_W, B_L) = \tfrac{3}{4} B_W + \tfrac{1}{4} B_L$$

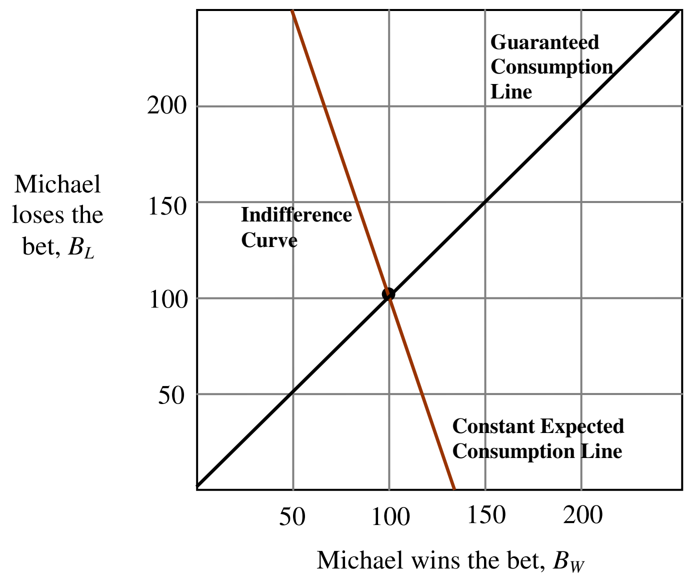
Using this formula, plug-in the point $(B_W, B_L) = (100,100)$ to find that $U(B_W, B_L) = 100$. So points on the indifference curve through the point $(B_W, B_L) = (100,100)$ satisfy the formula $100 = \tfrac{3}{4} B_W + \tfrac{1}{4} B_L$. Now, solve for B_L.

$$100 = \tfrac{3}{4} B_W + \tfrac{1}{4} B_L$$

$$\tfrac{1}{4} B_L = 100 - \tfrac{3}{4} B_W$$

$$B_L = 400 - 3B_W$$

The constant expected consumption line that runs through the point $(B_W, B_L) = (100,100)$ satisfies the formula $\tfrac{3}{4} B_W + \tfrac{1}{4} B_L = 100$, which can be rewritten as $B_L = 400 - 3B_W$. Notice that the indifference curve is the same as the constant expected consumption line at all points including the point $(B_W, B_L) = (100,100)$. Michael is therefore risk neutral.



8. Michael's expected utility function is,

$$U(B_W, B_L) = \tfrac{3}{4} B_W^2 + \tfrac{1}{4} B_L^2$$

Using this formula, plug-in the point $(B_W, B_L) = (100,100)$ to find that $U(B_W, B_L) = 10$. So points on the indifference curve through the point $(B_W, B_L) = (100,100)$ satisfy the formula $10{,}000 = \tfrac{3}{4} B_W^2 + \tfrac{1}{4} B_L^2$. Now, solve for B_L.

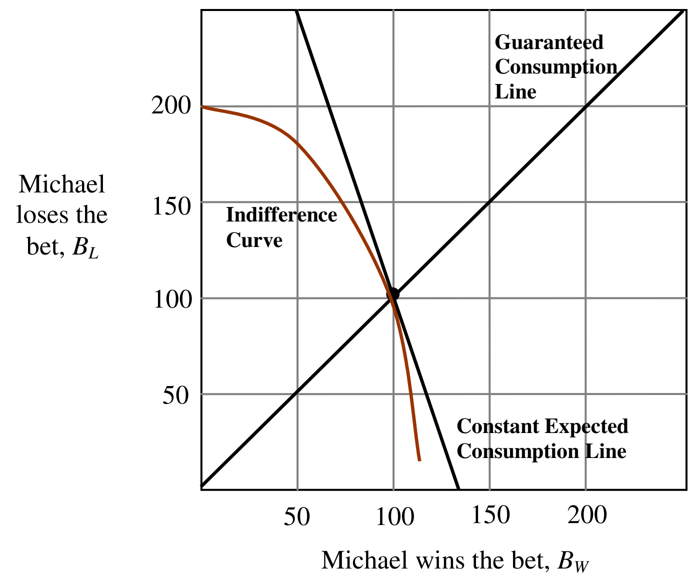
$$10{,}000 = \tfrac{3}{4} B_W + \tfrac{1}{4} B_L$$

$$\tfrac{1}{4} B_L^2 = 10{,}000 - \tfrac{3}{4} B_W^2$$

$$B_L^2 = 40{,}000 - 3B_W^2$$

$$B_L = \sqrt{40{,}000 - 3B_W^2}$$

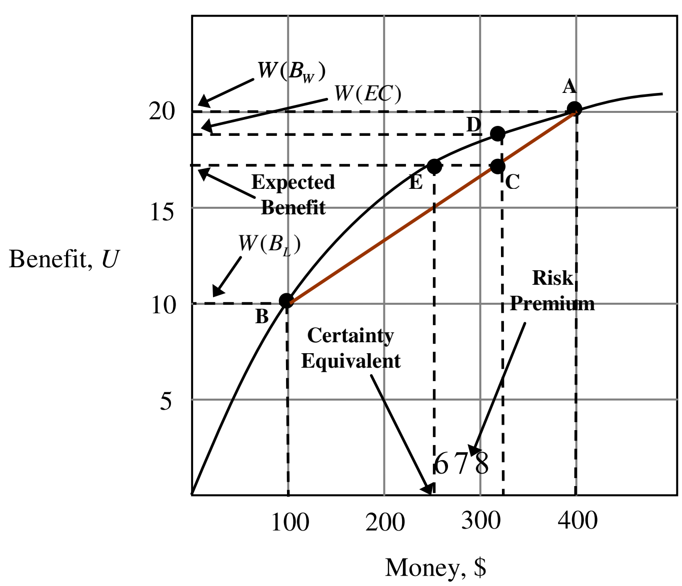
The constant expected consumption line that runs through the point $(B_W, B_L) = (100,100)$ satisfies the formula $\tfrac{3}{4} B_W + \tfrac{1}{4} B_L = 100$, which can be rewritten as $B_L = 400 - 3B_W$. Notice that the indifference curve is tangent to the constant expected consumption line at the point $(B_W, B_L) = (100,100)$, and below all other points on the line. Michael is therefore risk loving.



9. The benefit for the high state is represented by point A. The benefit for the low state is represented by point B.

The expected benefit is $\frac{3}{4}\sqrt{400}+\frac{1}{4}\sqrt{100}=17.5$. The $W(EC)$ is shown on the graph, and as you can see it is characteristically higher than the expected benefit.

The risk premium and certainty equivalent are also shown on the graph.



10. An insurance policy that is actuarially fair means that the policy has an expected net payoff of zero. People are willing to purchase insurance policies that are actuarially fair because they do not change the purchaser's expected consumption. This feature would be particularly sought after by someone who is risk averse.

11. Michael's available choices lie on the budget line $-\frac{(1-R)}{R}$. In this case $R = 0.4$, so the slope of the budget line is –l.5. The formula for Michael's budget line is thus $B_L = C - 1.5B_W$ where C is a constant. Michael's budget line must pass through the point, $(B_W, B_L) = (324, 64)$, we know that $64 = C - (1.5 \times 324)$ so $C = 550$.

Michael's best choice is the point where his budget line and indifference curves are tangent to each other. At any best choice point, the slopes of the budget line and the indifference curve must be the same. Therefore,

$$-1.5 = -MRS_{WL} = \frac{3\sqrt{B_L}}{\sqrt{B_W}}$$

Using this formula, then solve for B_L which gives you, $B_L = .25B_W$.

Now we can use both $B_L = 550 - 1.5B_W$ and $B_L = .25B_W$ to find Michael's best choice, by solving algebraically.

$$.25B_W = 550 - 1.5B_L$$

$$B_W = \frac{550}{1.75} \approx \$314.29$$

Michael spends \$314.29 if he wins. Since Michael started with \$324 he did buy insurance. He spent \$9.71 on insurance. This means that Michael's insurance benefit must be \$24.28 (since $0.4 \times 24.28 = 9.71$). If Michael gets the low state B_L, he spends $B_L = 64 + 24.28 - 9.71 = \$78.57$.

After purchasing insurance, Michael's risky bundle is $(B_W, B_L) = (314.29, 78.57)$. Points on the indifference curve that runs through this bundle satisfy the formula $\frac{3}{4}\sqrt{B_W} + \frac{1}{4}\sqrt{B_L} = \frac{3}{4}\sqrt{314.29} + \frac{1}{4}\sqrt{78.57} \approx 15.51$. To find a risk-less bundle on this indifference curve (where $B_W = B_L$), we solve:

$$\frac{3}{4}\sqrt{B} + \frac{1}{4}\sqrt{B} = 15.51$$

$$\sqrt{B} = 15.51$$

$$B = 240.56$$

B = \$240.56 is the certainty equivalent of Michael's risky bundle after purchasing insurance.

Michael's initial bundle is $(B_W, B_L) = (324, 64)$. This bundle satisfies the formula $\frac{3}{4}\sqrt{B_W} + \frac{1}{4}\sqrt{B_L} = \frac{3}{4}\sqrt{324} + \frac{1}{4}\sqrt{64} = 15.5$. Like before we need to find the risk-less bundle on this indifference curve, by solving:

$$\frac{3}{4}\sqrt{B} + \frac{1}{4}\sqrt{B} = 15.5$$
$$\sqrt{B} = 15.5$$
$$B = 240.25$$

\$240.25 represents the certainty equivalent of Michael's initial risky bundle. The value of the insurance is 31 cents, since $240.56 - 240.25 = 0.31$.

12. The answer to this problem has a similar approach to that of question (12). Michael's available choices lie on the budget line $-\frac{(1-R)}{R}$. In this case *R = 0.4*, so the slope of the budget line is –1.5. The formula for Michael's budget line is thus $B_L = C - 1.5B_W$ where C is a constant. Michael's budget line must pass through the point, $(B_W, B_L) = (400, 0)$, we know that $0 = C - (1.5 \times 400)$ so *C =600*.

At any best choice point, the slopes of the budget line and the indifference curve must be the same. Therefore,

$$-1.5 = -MRS_{WL} = \frac{3\sqrt{B_L}}{\sqrt{B_W}}$$

Using this formula, then solve for B_L which gives you, $B_L = .25B_W$.
Now we can use both $B_L = 600 - 1.5B_W$ and $B_L = .25B_W$ to find Michael's best choice, by solving algebraically.

$$.25B_W = 600 - 1.5B_W$$
$$B_W = \frac{600}{1.75} \approx \$342.86$$

Michael spends \$342.86 if he wins. Since Michael started with \$400 he did buy insurance. He spent \$57.14 on insurance. This means that Michael's insurance benefit must be \$142.85 (since $0.4 \times 142.85 = 57.14$). If Michael gets the low state B_L, he spends $B_L = 0 + 142.85 - 57.14 = \$85.71$.

After purchasing insurance, Michael's risky bundle is $(B_W, B_L) = (342.86, 85.71)$ .Points on the indifference curve that runs through this bundle satisfy the formula $\frac{3}{4}\sqrt{B_W} + \frac{1}{4}\sqrt{B_L} = \frac{3}{4}\sqrt{342.86} + \frac{1}{4}\sqrt{85.71} \approx 16.2$. To find a risk-less bundle on this indifference curve (where $B_W = B_L$), we solve:

$$\tfrac{3}{4}\sqrt{B} + \tfrac{1}{4}\sqrt{B} = 16.2$$
$$\sqrt{B} = 16.2$$
$$B = 262.44$$

B = *\$262.44* is the certainty equivalent of Michael's risky bundle after purchasing insurance.

Michael's initial bundle is $(B_W, B_L) = (400,0)$. This bundle satisfies the formula $\tfrac{3}{4}\sqrt{B_W} + \tfrac{1}{4}\sqrt{B_L} = \tfrac{3}{4}\sqrt{400} = 15$. Like before we need to find the risk-less bundle on this indifference curve, by solving:

$$\tfrac{3}{4}\sqrt{B} + \tfrac{1}{4}\sqrt{B} = 15$$
$$\sqrt{B} = 15$$
$$B = 225$$

\$225 represents the certainty equivalent of Michael's initial risky bundle. The value of the insurance is \$37.44, since $262.44 - 225 = 37.44$.

13. In practice, diversification involves undertaking many risky activities, each on a small scale, whereas hedging refers to the undertaking of two risky activities with negatively correlated financial payoffs. Hedging is a case in which diversification is particularly effective at reducing risk. Diversification can be used to mitigate risk because with diversification you would invest in many activities on small scale that are uncorrelated so that the probability of having all your activities perform poorly is small. Hedging helps reduce risk because you are essentially betting big on the only two possible outcomes so that you will always have invested on the winning outcome. Therefore, you would lose from the one investment, but ideally your other investment would offset your loss.

14. If Michael's expected benefit is $\sqrt{X}$, then keeping \$400 will guarantee him a benefit of 20. The certainty equivalent is simply \$400. Investing \$200 in the company will produce an expected benefit of,

$$0.5\sqrt{200} + 0.5\sqrt{0} = 7.07$$

Michael's certainty equivalent is the amount X that solves $\sqrt{X} = 7.07$, so X = *49.98.* So, Michael's best choice is to keep his money, and not invest.

15. As we saw in (14) if Michael keeps the \$400, he is guaranteed a benefit of 20, and a certainty equivalent of \$400. Investing \$400 in the company will produce an expected benefit of,

$$0.3\sqrt{800} + 0.4\sqrt{400} + 0.3\sqrt{0} = 16.49$$

Michael's certainty equivalent is the amount X that solves $\sqrt{X} = 16.49$, so X = *271.92.* So, Michael's best choice is to keep his money, and not invest. Any investment that is under \$400 will improve the investment option but not enough to change the best choice of not investing.

Chapter 12

1.

		PLAYER A	
		STAY	SWERVE
PLAYER B	STAY	-6 / -6	4 / -2
	SWERVE	-2 / 4	-2 / -2

2.

		FIRM A		
		P_L	P_M	P_H
FIRM B	P_L	100 / 100	600 / 50	800 / 0
	P_M	50 / 600	250 / 250	300 / 200
	P_H	0 / 800	200 / 300	500 / 500

3.

		PLAYER A	
		LEFT	RIGHT
PLAYER B	UP	12 / 15	20 / 7
	DOWN	9 / 11	8 / 16

Player B has a dominant strategy of choosing "up", because regardless of player A's decision player B's best choice is still "up". Player A does not have a dominant strategy because his/her best strategy depends upon what player B chooses.

4. When a strategy is weakly dominated it means that there is some other strategy that yields a strictly higher payoff in some circumstances. A strictly dominated strategy is different from a weakly dominated strategy in that with a strictly dominated strategy there is some other choice that yields a strictly greater payoff.

5. Regardless of whether player A chooses "left or right", player B's best response is to choose up. If player B's best response is "up" then player A's best response is "left." Therefore the Nash Equilibrium is (up, left).

6. Regardless of whether Firm A chooses "low or high", Firm B's best response is "low". If Firm B chooses "low" then Firm A will choose "low" as its best response. Thus, the Nash Equilibrium is (low, low).

   This game is similar to the prisoner's dilemma because like the prisoner's dilemma, the Nash equilibrium does not yield the highest profit. The most profitable outcome for both firms would be (high, high).

7. If Nina works X hours, then Margaret's best response can be found by setting her marginal benefit equal to her marginal cost: $4Y = 48 - 2(X + Y)$. Solving for Y, produces the formula that describes the relationship between Nina's choices and Margaret's best responses:

$$Y = 8 - \tfrac{1}{3}X$$

   Now, if Margaret works Y hours, then Nina's best response can be found in a similar fashion. Set marginal benefit equal to marginal cost, then solve for X:

$$X = 8 - \tfrac{1}{3}Y$$

   In order to find the Nash equilibrium, we need to find the values of X and Y that satisfy both best response formulas at the same time. To do this, substitute the first formula into the second formula:

$$X = 8 - \tfrac{1}{3}(8 - \tfrac{1}{3}X)$$

$$X = 8 - \tfrac{8}{3} + \tfrac{1}{9}X$$

$$\tfrac{8}{9}X = \tfrac{16}{3}$$

$$X = \tfrac{144}{24} = 6$$

   Thus, we find that $X = 6$. Plugging this value for X into the first formula, we find that Y = 6. So Nash equilibrium in this situation has both Nina and Margaret working for 6 hours.

   There are two more preferred outcomes for Nina and Margaret. The most preferred outcome would have been for both Margaret and Nina to work 8 hours because each would have received a net benefit of 384 which can be found by calculating the benefit and subtracting the cost ($[24(2(8)+2(8))-(8+8)^2-2(8)^2]=384$). The net benefit for 6 hours of work is 360 which is less than the 384 net benefit of 8 hours and the net benefit if both work 7 hours which is 378.

8. If Nina works X hours, then Margaret's best response can be found by setting her marginal benefit equal to her marginal cost: $2Y = 18 - 2(X+Y)$. Solving for Y, produces the formula that describes the relationship between Nina's choices and Margaret's best responses:

$$Y = \tfrac{1}{2}(9-X)$$

Now, if Margaret works Y hours, then Nina's best response can be found in a similar fashion. Set marginal benefit equal to marginal cost, then solve for X:

$$X = 6 - \tfrac{1}{3}Y$$

In order to find the Nash equilibrium, we need to find the values of X and Y that satisfy both best response formulas at the same time. To do this, substitute the first formula into the second formula:

$$X = 6 - \tfrac{1}{3}\left(\tfrac{9}{2} - \tfrac{1}{2}X\right)$$

$$X = 6 - \tfrac{9}{6} - \tfrac{1}{6}X$$

$$\tfrac{5}{6}X = \tfrac{9}{2}$$

$$X = \tfrac{54}{10} = 5.4$$

Thus, we find that $X = 5.4$ hours. Plugging this value for X into the first formula, we find that Y = 1.8 hours. So Nash equilibrium in this situation has both Nina works 5.4 hours and Margaret works for 1.8 hours.

The Nash equilibrium is the most preferred outcome. This can be checked by evaluating different hours of work for both Margaret and Nina and comparing the net benefit of the new outcomes.

9. A mixed strategy equilibrium is a strategy in which each player chooses a mixed strategy that is a best response to the mixed strategy chosen by the others. Mixed strategies are best used in multi-staged games.

10. For pure strategies, there are no Nash equilibria.

For mixed strategies, in equilibrium a player will not choose a dominated strategy as a best response. In the matrix above every choice can be dominated by the other player's response, therefore Nina and Margaret must randomize their choices. Let Q represent the probability that Nina holds up one finger. Let P represent the probability that Margaret holds up one finger. Nina's expected payoff from holding up one finger is $-2Q+10(1-Q)$, while her expected payoff from holding up two fingers is $10Q-2(1-Q)$. Since Nina's choice of P has to make Margaret indifferent between holding one finger or two fingers (so that she's willing to randomize between the two), we know that $-2Q+10(1-Q)=10Q-2(1-Q)$, which means that $Q = \frac{1}{2}$. Margaret's expected payoffs are identical to Nina's, therefore $P = \frac{1}{2}$. Therefore, the mixed strategy equilibrium is: Nina holds up one finger and two fingers up with 50% probability; Margaret holds up one finger and two fingers up with 50% probability.

11. For pure strategies there are no Nash equilibria.

    For mixed strategies, in equilibrium a player will not choose a dominated strategy as a best response. In the matrix above every choice can be dominated by the other player's response, therefore Nina and Margaret must randomize their choices. Let Q represent the probability that Nina holds up one finger. Let P represent the probability that Margaret holds up one finger. Nina's expected payoff from holding up one finger is $-4Q+10(1-Q)$, while her expected payoff from holding up two fingers is $8Q-4(1-Q)$. Since Nina's choice of P has to make Margaret indifferent between holding one finger or two fingers (so that she's willing to randomize between the two), we know that $-4Q+10(1-Q)=8Q-4(1-Q)$, which means that $Q = \frac{7}{13} \approx 53.8\%$. Margaret's expected payoffs are $10Q-2(1-Q)$ for one finger and $-2Q+10(1-Q)$ for two fingers; and by similar method we find that $P = \frac{1}{2}$. Therefore, the mixed strategy equilibrium is: Nina holds up one finger with 53.8% probability and two fingers up with 46.2% probability; Margaret holds up one finger and two fingers up with 50% probability.

12. To find the Nash equilibrium using backward induction we must first focus on player B's choices holding player A's choices constant. If player A swerves initially, player B's best option is to stay (payoff = 4). If player A stays initially, player B's best choice is to swerve (payoff = -2). Now, we can focus on player A's best decision based on what we know player B will do. If A stays we know B will swerve giving A a payoff of 4. If A swerves we know B will stay giving A a payoff of -2. Thus, A will choose to stay. As a result, the Nash equilibrium is (Stay, Swerve).

13. Using backward induction:
    Start by looking at player 1's decision in the final round. 1's best decision is to take the money. Using this information, we now focus on player 2's decision in the second round knowing what 1 will do in round 3. Player 2's best choice is to take the money and not wait. Finally, we can now focus on player 1's decision in round 1, knowing how 2 will react to if 1 waits. Therefore, the Nash equilibrium for this game is that player 1 takes the $1 in round one and ends the game.
    Allowing for additional rounds would not change the outcome of the game because backward induction would always lead us to the same outcome. The strategy of "wait" is strictly dominated by the strategy of "take."

14. A grim strategy in multiple stage games is one that threatens a permanent punishment for selfish behavior. The grim strategy could not be used in the game of chicken because it is only a two-stage game where player B cannot permanently punish player A for choosing a selfish choice with out negatively affecting him/herself.

15. There are two Nash equilibria: (80, 375) and (375, 80).

		FIRM A	
		P_L	P_H
FIRM B	P_L	50 / 50	80 / 375
	P_H	375 / 80	300 / 300

A possible grim strategy that could be devised is one in which both firms agree to charge high, and if one firm decides to price low the other firm will punish them permanently by pricing low from that period on. This would only work in a multi- or infinite-stage game, otherwise the threat of punishment would not be credible.

Chapter 13

1. Experiments have allowed economist to study things such as fairness, status and trust; issues that standard economic theories did not account for. Experiments have also allowed economists to gather information on a wide range of contexts that are difficult to find in real world data.

2. One advantage of conducting economic experiments is that through experiments it is easier to determine whether people's choices are consistent with standard economic theory. Another advantage of experiments is that researchers can double check their assumptions and conclusions by testing and making sure subjects understand instructions.

   On disadvantage of experiments is that they are undeniably conducted in artificial settings. This is a concern because subjects may not act like they normally would. Also, the small budgets for economic experiments mean that the stakes for participants are not very high. Another disadvantage of experiments that the subject pool's for most experiments comprises of college students, and they are conducted at universities. Critics of economic experiments point out that the subject pools are not representative of the population at large, and that this is cause to cast doubts on some experimental results.

3. Stating that $150 as the dollar amount that is just as good as the gamble when you took the $100 with violates the ranking principle and represents a choice reversal: two staples of standard economic theory. There is evidence that reversals decrease when decisions are repeated so that people learn from the consequences of their choices.

4. Anchoring refers to the concept where someone's choices are tied to memorable but clearly irrelevant information. The example of choosing lottery numbers based on anniversary dates, and birthdates falls under the category of people anchoring their decisions on irrelevant information that will not increase their chances of winning.

5. The default effect refers to the fact that when given many alternative choices, people often avoid making a choice and settle for the assigned default option. According to the default effect, the professor should have the in-class exam on the syllabus, but later offer the take-home exam and term paper as alternative options to the in-class exam. Evidence from economic experiments has shown that if the professor employs this strategy he/she should achieve the desired result.

6. Economic experiments have shown that people tend to value something more highly when they own it than when they don't, this phenomenon refers to the endowment effect. The existence of the endowment effect demonstrates that people might be unwilling to let go or change from the status quo because they value it more than change. The status quo represents what a person owns and a change from the status quo represents something the person doesn't own.

7. Jason would be more likely to take advantage of the sale in the second scenario because, according to the concept of narrow framing, Jason would view each scenario as such: in (1) the TV is on sale, but it is less than 5% off, where in (2), the DVD player is 50% off, making this seem like a better deal, even though both scenarios offer a savings of $150.

8. One solution involves the notion of precommitment which precludes a person from making a bad decision by restricting their future options. For someone who is trying to quit smoking this could involve throwing their cigarettes away before they have another craving. Another possibility could involve avoiding places that encourage the person's smoking habit.

9. First start by looking at Brian's utility from Sunday's perspective. Brian's utility will be $16-6=20$ if he washes Vincent on Monday, $13-6=7$ if he does it on Tuesday, $10-6=4$ if he does it on Wednesday, $7-6=1$ if he does it on Thursday, and $4-6=-2$ if he does it on Friday.

   To determine what Brian will actually do, analyze a few hypothetical situations. Suppose Wednesday arrives and Vincent is still dirty. Brian can either do it on Wednesday or wait until Thursday to wash Vincent. If he does it on Wednesday, his utility (from Wednesday's perspective) will be $2(-6)+10=-2$. Should he wait until Thursday from Wednesday's perspective his utility will be $7-6=1$. Since 1 > -2, he will not wash Vincent on Thursday.

   Now, suppose Tuesday rolls around and Vincent is still dirty. Brian can either do it on Tuesday or delay. If he does it on Tuesday, his utility (from Tuesday's perspective) will be $2(-6)+13=1$. If he delays he will end up washing Vincent on Wednesday, so his utility (from Tuesday's perspective) will be 10 – 6 = 4. Since 4 > 1, Brian will do the chore on Wednesday.

   On Monday, Brian can either do the chore or delay. Should he wash Vincent on Monday his utility from Monday's perspective will be $2(-6)+16=4$. If he postpones, Vincent won't be clean until Wednesday, so his utility (from Monday's perspective) will be 10 – 6 =4. Since 4 = 4, he is indifferent between washing Vincent on Monday or Wednesday.

   As of Sunday Brian will want to wash Vincent on Monday. Based on the reasoning above, Brian will wash Vincent on Monday. He is dynamically consistent, and he will follow through on Sunday's intentions.

10. First start by looking at Brian's utility from Sunday's perspective. Brian's utility will be $10-2=8$ if he washes Vincent on Monday, $8-2=6$ if he does it on Tuesday, $6-2=4$ if he does it on Wednesday, $4-2=2$ if he does it on Thursday, and $2-2=0$ if he does it on Friday.

To determine what Brian will actually do, analyze a few hypothetical situations. Suppose Wednesday arrives and the litter box still stinks. Brian can either do it on Wednesday or wait until Thursday to clean the litter box. If he does it on Wednesday, his utility (from Wednesday's perspective) will be $2(-2)+6=2$. Should he wait until Thursday from Wednesday's perspective his utility will be $4-2=2$. Since 2 = 2, he is indifferent from cleaning the litter box on Wednesday and Thursday.

Now, suppose Tuesday rolls around and the litter box still stinks. Brian can either do it on Tuesday or delay. If he does it on Tuesday, his utility (from Tuesday's perspective) will be $2(-2)+8=4$. If he delays he will end up cleaning the litter box on Wednesday, so his utility (from Tuesday's perspective) will be $6-2=4$. Since 4 = 4, Brian will do the chore on Tuesday, because delaying won't make a difference.

On Monday, Brian can either do the chore or delay. Should he clean the litter box on Monday his utility from Monday's perspective will be $2(-2)+10=6$. If he postpones, the litter box will stink until Tuesday, so his utility (from Monday's perspective) will be $8-2=6$. Since 6 = 6, he is indifferent between cleaning the litter box Monday or Tuesday.

As of Sunday Brian want to clean the litter box on Monday. Based on the reasoning above, Brian will clean the litter box on Monday. He is dynamically consistent, and he will follow through on Sunday's intentions.

11. First start by looking at Brian's utility from Sunday's perspective. Brian's utility will be $10-2=8$ if he washes Vincent on Monday, $8-2=6$ if he does it on Tuesday, $6-2=4$ if he does it on Wednesday, $4-2=2$ if he does it on Thursday, and $2-2=0$ if he does it on Friday. So as of Sunday, Monday is the best option.

    Suppose Wednesday arrives and the litter box still stinks. Brian can either do it on Wednesday or wait until Thursday to clean the litter box. If he does it on Wednesday, his utility (from Wednesday's perspective) will be $3(-2)+2(6)=6$. Should he wait until Thursday from Wednesday's perspective his utility will be $4-2=2$. Since 6 > 2, he will clean the litter box on Wednesday.

    Now, suppose Tuesday rolls around and the litter box still stinks. Brian can either do it on Tuesday or delay. If he does it on Tuesday, his utility (from Tuesday's perspective) will be $3(-2)+2(8)=10$. If he delays he will end up cleaning the litter box on Wednesday, so his utility (from Tuesday's perspective) will be $8-2=6$. Since 10 > 6, Brian will do the chore on Tuesday, because delaying would decrease his utility.

    On Monday, Brian can either do the chore or delay. Should he clean the litter box on Monday his utility from Monday's perspective will be $3(-2)+2(10)=16$. If he postpones, the litter box will stink until Tuesday, so his utility (from Monday's perspective) will be $8-2=6$. Since 16 > 6, he will clean the litter box Monday.

As of Sunday Brian want to clean the litter box on Monday. Based on the reasoning above, Brian will clean the litter box on Monday. He is dynamically consistent, and he will follow through on Sunday's intentions.

12. People that wish they'd had 5 more minutes with a loved one after they pass away are evaluating how they would have felt based on how they are feeling at the moment when a loved one passes, which is typically miserable. So one might feel at the present that 5 more minutes would assuage your current grief, but this is exactly what the projection bias tells us might happen in such a situation.

13. If Jason believes in the gambler's fallacy he will bet on black because he will reason that red is less likely. If Jason believes in the hot-handed fallacy he will bet on red because he will think that red is more likely to come up because it keeps coming up. The reasoning for both bets is in error, because the probability of red or black is equally likely and independent of prior outcomes.

14. We need to solve for the expected valuation of each risky prospect using expressions for positive and negative values of *X*.
    If *X* = 10, then $V(10) = 20(10) - (10)^2 = 100$. The weight attached to $V(10)$ is $W(0.5) = 0.001 + 0.998(0.5) = 0.5$, while the weight attached to $V(-10) = 25(-10) + (-10)^2 = -150$ is $W(0.5) = 0.001 + 0.998(0.5) = 0.5$.The value of this option is $[0.5 \times 100] + [0.5 \times -150] = -25$.
    If *X* = 100, then $V(100) = 20(100) - (100)^2 = -8{,}000$. The weight attached to $V(100)$ is $W(0.5) = 0.001 + 0.998(0.5) = 0.5$, while the weight attached to $V(-100) = 25(-100) + (-100)^2 = 7500$ is $W(0.5) = 0.001 + 0.998(0.5) = 0.5$.The value of this option is $[0.5 \times -8000] + [0.5 \times -7500] = -7750$.
    Jason would not accept either gambles because they both offer negative payoffs.

15. We need to solve for the expected valuation of each risky prospect using expressions for positive and negative values of *X*.
    If *X* = 10, then $V(10) = 40(10) - (10)^2 = 300$. The weight attached to $V(10)$ is $W(0.5) = 0.001 + 0.998(0.5) = 0.5$, while the weight attached to $V(-10) = 25(-10) + 2(-10)^2 = -50$ is $W(0.5) = 0.001 + 0.998(0.5) = 0.5$.The value of this option is $[0.5 \times 300] + [0.5 \times -50] = 125$.

    If *X* = 100, then $V(100) = 40(100) - (100)^2 = -6{,}000$. The weight attached to $V(100)$ is $W(0.5) = 0.001 + 0.998(0.5) = 0.5$, while the weight attached to $V(-100) = 25(-100) + 2(-100)^2 = 17{,}500$ is $W(0.5) = 0.001 + 0.998(0.5) = 0.5$.The value of this option is $[0.5 \times -6000] + [0.5 \times -17500] = -11{,}750$.

    Jason would accept the first gamble that pays \$10. He would not accept the \$100 gamble because it offers negative payoffs.

16. In a dictator game one player is given control of the money given, and that person has the right to give the second player however much or however little they wish without repercussions. The ultimatum game's critical difference is that the player chosen to receive whatever money is sent can refuse the offer made to them. When the receiving player refuses the amount sent, the typical ultimatum game will not payout, thereby punishing not only player 2 but also player 1 as well; unlike the dictator game.

    These games can be used to test for emotions such as altruism and fairness, as well as anger. The dictator game can test for a subject's sense of fairness and altruism because the player that is given the first move has no obligation to split the money given, and since the game offers anonymity, it controls for a player sharing the money because social repercussions.

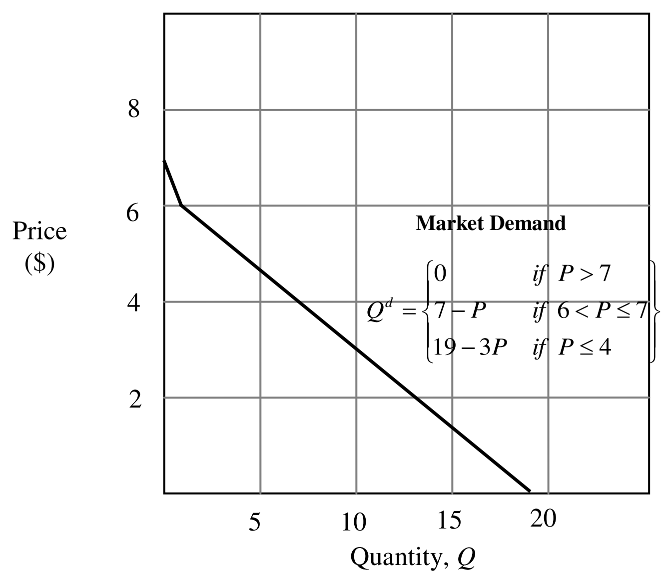
    The ultimatum game can test for a subject's sense of anger because the player that is given the second move has the opportunity to refuse the offer given by the player with the first move if they feel it is not enough.

Chapter 14

1. The three main characteristics of a perfectly competitive market are: buyers and sellers don't have transaction costs; products are homogenous meaning that every seller produces the same product and consumers can't tell what seller produced what; and lastly, there are many sellers in the market such that every seller has a fraction of the market supply.

   The presence of these factors inhibits sellers from charging a price above the market price. The large number of sellers in the market coupled with their lack of market power means that each firm must price at the market price; any firm that prices above the market price will lose their customer's. The fact that goods are homogenous means that if one firm decides to price above the market price customer's will not miss this firms product because every other firm in the market offers the same good. Thus, firms in a perfectly competitive market are price takers.

2.



To find the market demand, first find the respective inverse demand functions and solve for the P-intercept:

$$Q_M^d = 7 - P \Leftrightarrow P = 7 - Q\text{; } P\text{-intercept} = 7.$$

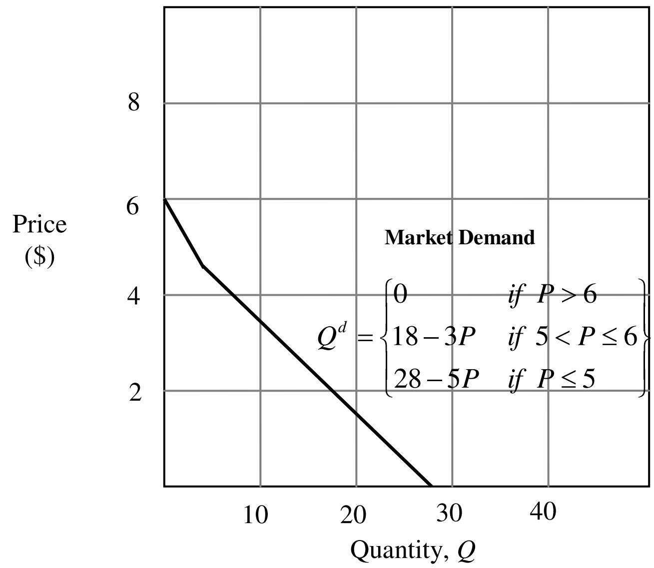
$$Q_J^d = 12 - 2P \Leftrightarrow P = 6 - \frac{Q}{2}\text{; } P\text{-intercept} = 6.$$

Now we may proceed as follows:

At prices below \$6 only the market demand is $Q^d = Q_M^d + Q_J^d = (7 - P) + (12 - 2P) = 19 - 3P$. For prices between \$6 and \$7 dollars, only Marie buys pizza, so the market demand function is $Q_M^d = 7 - P$. At prices above \$7, neither Marie nor, Jerry demand pizza.

$$Q^d = \begin{cases} 0 & if\ P > 7 \\ 7 - P & if\ 6 < P \le 7 \\ 19 - 3P & if\ P \le 4 \end{cases}$$

3.



To find the market demand, first find the respective inverse demand functions and solve for the *P*-intercept:

$$Q_M^d = 10 - 2P \Leftrightarrow P = 5 - \frac{Q}{2}\text{; } P\text{-intercept} = 5.$$

$$Q_J^d = 18 - 3P \Leftrightarrow P = 6 - \frac{Q}{3}\text{; } P\text{-intercept} = 6.$$

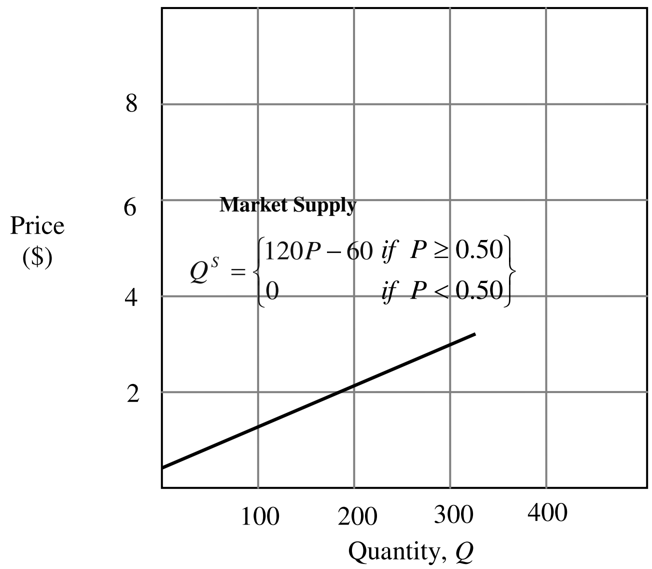
Now we may proceed as follows:

At prices below \$5 only the market demand is $Q^d = Q_M^d + Q_J^d = (10 - 2P) + (18 - 3P) = 28 - 5P$. For prices between \$5 and \$6 dollars, only Jerry buys pizza, so the market demand function is $Q_J^d = 18 - 3P$. At prices above \$6, neither Jerry nor, Marie demand pizza.

$$Q^d = \begin{cases} 0 & if\ P > 6 \\ 18 - 3P & if\ 5 < P \le 6 \\ 28 - 5P & if\ P \le 5 \end{cases}$$

4. To find the market supply, first solve the function $Q^S = 40P - 20$ in terms of Q and get the P-intercept. In this case at $Q = 0$, $P = 0.50$. Each firm in this market has a function $Q^S = 40P - 20$, thus if there are 3 firms in the market the market supply:

$$Q^S = \begin{Bmatrix} 120P - 60 & if\ \ P \geq 0.50 \\ 0 & if\ \ P < 0.50 \end{Bmatrix}$$



5. To determine the long-run market supply curve first find the output level at which marginal cost equals average cost.

$$MC = 2 + Q/20 = 45/Q + 2 + Q/40 = AC$$

$$Q/40 = 45/Q$$

$$Q^2 = 1800$$

$$Q \approx 42.43$$

Substituting this quantity into the expression for average cost tells us that

$$AC_{\min} = 45/42.43 + 2 + 42.43/40 = \$4.12$$

is the price at which the long-run market supply curve is a horizontal line. At prices under \$4.12, the long-run supply is zero; and at prices above \$4.12, it is infinite.

6. To determine the long-run market supply curve first find the output level at which marginal cost equals average cost.

$$MC = 3 + Q/16 = 25/Q + 3 + Q/32 = AC$$

$$Q/32 = 25/Q$$

$$Q^2 = 800$$

$$Q \approx 28.28$$

Substituting this quantity into the expression for average cost tells us that

$$AC_{\min} = 25/28.28 + 3 + 28.28/32 = \$4.77$$

is the price at which the long-run market supply curve is a horizontal line. At prices under \$4.77, the long-run supply is zero; and at prices above \$4.77, it is infinite.

7. The long-run market equilibrium price equals the $AC_{\min}$; we found the price to be \$4.12, in problem (5). Now we need to find out how many pizzas are produced and sold every day in equilibrium. To find this we must evaluate the total quantity demanded at \$4.12: $Q^d = 650 - 100(4.12) = 238$. Lastly, in a long-run equilibrium each active firm produces 42.43 pizzas. This means that there are about 5.61 firms.

8. The long-run market equilibrium price equals the $AC_{\min}$; we found the price to be \$4.77, in problem (6). Now we need to find out how many pizzas are produced and sold every day in equilibrium. To find this we must evaluate the total quantity demanded at \$4.12: $Q^d = 495 - 60(4.77) = 208.80$. Lastly, in a long-run equilibrium each active firm produces 28.28 pizzas. This means that there are about 7.38 firms.

   If the market demand increases to $Q^d = 990 - 120P$, then in the short-run the number of producers is fixed at 7.38 firms. To the short-run market supply, first find the supply function for each individual firm. In the short-run fixed costs are sunk and thus we don't have to account for them. Thus, setting P = MC:

$$P = 3 + Q/16 \Leftrightarrow Q = 16P - 48$$

   Since there are no fixed costs the $AC_{\min} = \$3$.

$$S(P) = \begin{Bmatrix} 16P - 48 & \text{if } P \geq 3 \\ 0 & \text{if } P \leq 3 \end{Bmatrix}$$

   Since there are 7.38 producers in the pizza market, the short-run market supply function is

$$S(P) = \begin{Bmatrix} 118.08P - 354.24 & \text{if } P \geq 3 \\ 0 & \text{if } P \leq 3 \end{Bmatrix}$$

   Now, we equate supply and demand to find the short-run market equilibrium.

$$118.08P - 354.24 = 990 - 120P$$
$$P \approx \$5.65$$

The total number of pizza's sold each day at the price \$5.65 in equilibrium is 312.91 pizzas, where each active firm sells 42.4 pizza's.

9. No, the long-run price will not always remain the same. If the demand in a market doubles, the price would almost certainly increase; however, in the long-run in a competitive and free entry market the increase in demand would attract new producers that would dissolve the short-run producer's surplus, driving the price back-down to the competitive level.

10. To find Marie's willingness to pay for 4 slices of pizza, find the P-intercept and evaluate at Q = 4. If Q = 4, then $4 = 7 - P \Rightarrow P = 3$. The P-intercept is 7. Her willingness to pay is the area under the line from the P-intercept to where P = 3.
$$WTP_{Marie} = (3 \times 4) + \tfrac{1}{2}((7-3)(4)) = \$20$$

If Q = 4, then $4 = 12 - 2P \Rightarrow P = 4$. Jerry's willingness to pay for 4 slices is:
$$WTP_{Jerry} = (4 \times 4) + \tfrac{1}{2}((6-4)(4)) = \$20$$

11. In this instance the firm's avoidable cost of making 180 slices can be found by measuring the area under the market supply curve up to the quantity of 180. If Q = 180, then $180 = 40P - 20 \Rightarrow P = \$5$. The supply curve may be rewritten as $P = Q/40 + 1/2$.
$$TAC = \tfrac{1}{2}(180) + \tfrac{1}{2}((5 - \tfrac{1}{2})(180)) = 405$$

The avoidable cost of making 220 slices is,
$$TAC = \tfrac{1}{2}(220) + \tfrac{1}{2}((5 - \tfrac{1}{2})(220)) = 605$$

12. A deadweight loss is a reduction in aggregate surplus below its maximum possible value. It arises as a result of various market interventions, such as government subsidies, trade tariffs, or if the amount that consumers demand is not met by suppliers.

13. First, solve for both inverse the demand and inverse supply functions. $Q^d = 200 - P \Rightarrow P = 200 - Q^d$ and, $Q^S = 2P - 100 \Rightarrow P = Q^S/2 + 50$. Equate the function for price in terms of quantity demand to the function for price in terms of quantity supply to solve for the market equilibrium $P^* = \$100$ & $Q^* = 100$.

If we were to draw a horizontal line from $P^* = \$100$, consumer surplus would be the area above this line but below the curve $P = 200 - Q^d$, thus
$$CS = \tfrac{1}{2}((200-100)(100)) = 5000$$

If we were to take the same horizontal line from $P^* = \$100$, the producer surplus would be the area below this line but above the curve $P = {Q^S}/{2} + 50$, thus

$$PS = 1/2((100-50)(100)) = 2500$$

Aggregate surplus represents a total surplus which includes both CS and PS. Thus aggregate surplus, AS = 7500.

14. First, solve for both inverse the demand and inverse supply functions. $Q^d = 28-5P \Rightarrow P = 28/5 - Q^d/5$ and, $Q^S = 10P-2 \Rightarrow P = Q^S/10 + 1/5$. Equate the function for price in terms of quantity demand to the function for price in terms of quantity supply to solve for the market equilibrium $P^* = \$2$ & $Q^* = 18$.

    If we were to draw a horizontal line from $P^* = \$2$, consumer surplus would be the area above this line but below the curve $P = 28/5 - Q^d/5$, thus

    $$CS = 1/2((28/5 - 2)(18)) = 32.4$$

    If we were to take the same horizontal line from $P^* = \$2$, the producer surplus would be the area below this line but above the curve $P = Q^S/10 + 1/5$, thus

    $$PS = 1/2((2 - 1/5)(18)) = 16.2$$

    Aggregate surplus represents a total surplus which includes both CS and PS. Thus aggregate surplus, $AS = 32.4 + 16.2 = 48.6$.

15. First, solve for both inverse the demand and inverse supply functions. $Q^d = 13-3P \Rightarrow P = 13/3 - Q^d/3$ and, $Q^S = 7P-2 \Rightarrow P = Q^S/7 + 2/7$. Equate the function for price in terms of quantity demand to the function for price in terms of quantity supply to solve for the market equilibrium $P^* = \$1.50$ & $Q^* = 8.5$.

    If we were to draw a horizontal line from $P^* = \$1.50$, consumer surplus would be the area above this line but below the curve $P = 13/3 - Q^d/3$, thus

    $$CS = 1/2((13/3 - 1.5)(8.5)) = 12.04$$

    If we were to take the same horizontal line from $P^* = \$1.50$, the producer surplus would be the area below this line but above the curve $P = Q^S/7 + 2/7$, thus

    $$PS = 1/2((1.5 - 2/7)(8.5)) = 5.16$$

    Aggregate surplus represents a total surplus which includes both CS and PS. Thus aggregate surplus, $AS = 12.04 + 5.16 = 17.2$.

Chapter 15

1. An 18 cent tax on each gallon of gas is a specific tax. A 7.56% payroll tax is and ad valorem tax. An 8.25% sales tax is also an ad valorem tax. A $1.25 tax on cigarettes is a specific tax.

2. To find which group will share the greater tax burden use the formula,

$$Consumer's\ share\ of\ tax = \frac{E^S}{E^S - E^D}$$

(1) [-5, 1.2]:

$$CSTax = \frac{1.2}{1.2 - -5} = \frac{6}{31}$$

Here, the producers bear the greater burden ($25/31$).

(2) [-2, 0.2]:

$$CSTax = \frac{0.2}{0.2 - -2} = \frac{1}{11}$$

Here, the producers bear the greater burden ($10/11$).

(3) [-0.8, 1]:

$$CSTax = \frac{1}{1 - -0.8} = \frac{5}{9}$$

Here, the consumer's bear the greater burden ($5/9$).

(4) [-1, 1.4]:

$$CSTax = \frac{1.4}{1.4 - -1} = \frac{7}{12}$$

Here, the consumer's bear the greater burden ($7/12$).

(4) [-1.3, 1.3]:

$$CSTax = \frac{1.3}{1.3 - -1.3} = \frac{1}{2}$$

Here, the consumer's and producers equally bear the burden.

3. To find the competitive market equilibrium set the market demand function equal to the market supply function and find the equilibrium price, then use the price to find the equilibrium quantity.

$$200 - P = 2P - 100$$
$$300 = 3P$$
$$P = 100$$

If P = $100, then $Q = 200 - (100) = 100$.

Now we need to find the consumer surplus, producer surplus and aggregate surplus.

$$CS = 1/2(200 - 100)(100) = 5000$$

$$PS = \tfrac{1}{2}(100-50)(100) = 2500$$
$$AS = 5000 + 2500 = 7500$$

The \$15 tax on each down blanket changes the market supply function to

$$Q^S = 2(P_b - 15) - 100 = 2P_b - 130$$

where P_b is the price paid by consumers. Now we need to find the equilibrium level of P_b, and again we set demand equal to supply:

$$200 - P_b = 2P_b - 130$$
$$330 = 3P_b$$
$$P_b = \$110$$

If P_b = \$110, then sellers must receive P_s = \$95 per down blanket. Substituting P_b = \$110 we find that $Q = 200 - 110 = 90$ blankets are sold.

Next, we need to find the consumer surplus, producer surplus, aggregate surplus, and now the deadweight loss.

$$CS = \tfrac{1}{2}(200-110)(90) = 4050$$
$$PS = \tfrac{1}{2}(95-50)(90) = 2025$$
$$AS = 4050 + 2025 = 6075$$

To find the deadweight loss we need to look at the difference in quantities pre- and post-tax and the difference in prices between consumers and producers post-tax.

$$DWL = \tfrac{1}{2}(100-90)(110-95) = 75$$

The deadweight loss of this tax is \$75.

4. To find the competitive market equilibrium set the market demand function equal to the market supply function and find the equilibrium price, then use the price to find the equilibrium quantity.

$$28 - 5P = 10P - 2$$
$$30 = 15P$$
$$P = \$2$$

If P = \$2, then $Q = 28 - 5(2) = 18$.

Now we need to find the consumer surplus, producer surplus and aggregate surplus.

$$CS = \tfrac{1}{2}(5.6-2)(18) = 32.4$$
$$PS = \tfrac{1}{2}(2-0.2)(18) = 16.2$$
$$AS = 32.4 + 16.2 = 50.4$$

The \$0.30 tax on each slice of pizza changes the market supply function to

$$Q^S = 10(P_b - 0.30) - 2 = 10P_b - 5$$

where P_b is the price paid by consumers. Now we need to find the equilibrium level of P_b, and again we set demand equal to supply:

$$28-5P_b=10P_b-5$$
$$33=15P_b$$
$$P_b=\$2.2$$

If P_b = \$2.2, then sellers must receive P_s =\$1.70 per pizza slices. Substituting P_b = \$2.2 we find that $Q=10(2.2)-5=17$ slices of pizza are sold.

Next, we need to find the consumer surplus, producer surplus, aggregate surplus, and now the deadweight loss.

$$CS=\tfrac{1}{2}(5.6-2.2)(17)=28.9$$
$$PS=\tfrac{1}{2}(1.70-0.2)(17)=12.75$$
$$AS=28.9+12.75=41.65$$

To find the deadweight loss we need to look at the difference in quantities pre- and post-tax and the difference in prices between consumers and producers post-tax.

$$DWL=\tfrac{1}{2}(18-17)(2.2-2)=0.1$$

The deadweight loss of this tax is 0.1.

5. To find the competitive market equilibrium set the market demand function equal to the market supply function and find the equilibrium price, then use the price to find the equilibrium quantity.

$$13-3P=7P-2$$
$$10=15P$$
$$P=1.5$$

If P = \$1.5, then $Q=13-3(1.5)=8.5$.

Now we need to find the consumer surplus, producer surplus and aggregate surplus.

$$CS=\tfrac{1}{2}(\tfrac{13}{3}-1.5)(8.5)=12.04$$
$$PS=\tfrac{1}{2}(1.5-\tfrac{2}{7})(100)=5.16$$
$$AS=27.63+5.16=17.2$$

The \$0.50 tax on each refrigerator magnet changes the market supply function to

$$Q^S=7(P_b-0.50)-2=7P_b-5.5$$

where P_b is the price paid by consumers. Now we need to find the equilibrium level of P_b, and again we set demand equal to supply:

$$13-3P_b=7P_b-5.5$$
$$18.5=10P_b$$
$$P_b=\$1.85$$

If P_b = \$1.85, then sellers must receive P_s = \$1 per refrigerator magnet. Substituting P_b = \$1.85 we find that $Q = 13 - 3(1.85) = 7.45$ refrigerator magnets are sold.
Next, we need to find the consumer surplus, producer surplus, aggregate surplus, and now the deadweight loss.

$$CS = \tfrac{1}{2}(\tfrac{13}{3} - 1.85)(7.45) = 9.25$$
$$PS = \tfrac{1}{2}(1 - \tfrac{2}{7})(7.45) = 2.66$$
$$AS = 9.25 + 2.66 = 11.91$$

To find the deadweight loss we need to look at the difference in quantities pre- and post-tax and the difference in prices between consumers and producers post-tax.

$$DWL = \tfrac{1}{2}(1.85 - 1.5)(8.5 - 7.45) = 0.18$$

The deadweight loss of this tax is 0.18.

6. The elasticity combination with the most elastic supply and most elastic demand would result in the largest deadweight loss. In this case it is combination, [-5,1.2].

7. From, question (4) we know that the competitive equilibrium before the subsidy is P = \$2 and Q = 18.

   From question (4) we also know that consumer surplus, producer surplus and aggregate surplus are:

$$CS = \tfrac{1}{2}(5.6 - 2)(18) = 32.4$$
$$PS = \tfrac{1}{2}(2 - 0.2)(18) = 16.2$$
$$AS = 32.4 + 16.2 = 50.4$$

The \$0.18 subsidy on each slice of pizza changes the market supply function to

$$Q^S = 10(P_b + 0.18) - 2 = 10P_b - 0.2$$

where P_b is the price paid by consumers. Now we need to find the equilibrium level of P_b, and again we set demand equal to supply:

$$28 - 5P_b = 10P_b - 0.2$$
$$28.8 = 15P_b$$
$$P_b = \$1.88$$

If P_b = \$1.88, then sellers must receive P_s =\$2.18 per pizza slice. Substituting P_b = \$1.88 we find that $Q = 10(1.88) - 0.2 = 16.8$ slices of pizza are sold.

Next, we need to find the consumer surplus, producer surplus, aggregate surplus, and now the deadweight loss.

$$CS = \tfrac{1}{2}(5.6 - 1.88)(16.8) = 31.25$$
$$PS = \tfrac{1}{2}(2.18 - 0.2)(16.8) = 18.14$$
$$AS = 31.25 + 18.14 = 49.35$$

To find the deadweight loss we need to look at the difference in quantities pre- and post-subsidy and the difference in prices between consumers and producers post-subsidy.

$$DWL = \frac{1}{2}(18-16.8)(2.18-1.88) = 0.18$$

The deadweight loss of this pizza subsidy is 0.18.

8. As we found in question (4) the equilibrium without interventions has a price of $2 per slice of pizza and 18 slices bought and sold each day. At a price of $3, consumers demand 13 slices of pizza while pizza producers want to supply 28 slices of pizza. The price floor policy would state that a slice of pizza could not be sold for more than $3. The price support program would have the government purchase 15 slices each year, which is the difference between the quantity demanded and quantity supplied at $3. A quota would distribute permits to pizza producers for selling 13 slices of pizza. In a voluntary production reduction program, the government would pay pizza producers to reduce their production from 28 slices to 13 slices per day.

   Now we must calculate the deadweight loss for each type of intervention: (use Figure 15.13 on p.558 of your textbook)

   Price floor:
   $DWL = \frac{1}{2}(18-13)(3-1.50) = 3.75$ ($1.50 is the price suppliers would charge if consumers would demand only 13 slices)

   Price support program:
   $$DWL = 3.75 + \frac{1}{2}(0.5)(18-13) + (1.5)(18-13) + \Lambda$$
   $$\Lambda + \frac{1}{2}(1.5-0)(28-18) + \frac{1}{2}(3-0)(28-18) = 35$$

   A quota program:
   $$DWL = \frac{1}{2}(18-13)(3-1.50) = 3.75$$

   The voluntary reduction production program:
   $$DWL = \frac{1}{2}(18-13)(3-1.50) = 3.75$$

9. As we found in question (3) the equilibrium without interventions has a price of $100 per down blanket and 100 blankets are bought and sold each day. At a price of $120, consumers demand 80 blankets while blanket producers will want to supply 140 down blankets. The price floor policy would state that a down blanket could not be sold for more than $120. The price support program would have the government purchase 60 blankets each year, which is the difference between the quantity demanded and quantity supplied at $120. A quota would distribute permits to down blanket producers for selling 80 down blankets. In a voluntary production reduction

program, the government would pay down blanket producers to reduce their production from 140 blankets to 80 blankets per day.

Now we must calculate the deadweight loss for each type of intervention: (use Figure 15.13 on p.558 of your textbook)

Price floor:

$DWL = \frac{1}{2}(100-80)(120-90) = 300$ (\$90 is the price suppliers would charge if consumers would demand only 80 blankets)

Price support program:

$$DWL = 300 + \frac{1}{2}(100-90)(100-80) + \frac{1}{2}(100-60)(140-100) + \Lambda$$
$$\Lambda + (60\times 40) + \frac{1}{2}(120-60)(100-40) = 5400$$

A quota program:

$$DWL = \frac{1}{2}(100-80)(120-90) = 300$$

The voluntary reduction production program:

$$DWL = \frac{1}{2}(100-80)(120-90) = 300$$

10. As we found in question (5) the equilibrium without interventions has a price of \$1.5 per down blanket and 8.5 refrigerator magnets are bought and sold each day. At a price of \$2.00, consumers demand 7 magnets while magnet producers will want to supply 12 refrigerator magnets. The price floor policy would state that a refrigerator magnet could not be sold for more than \$2.00. The price support program would have the government purchase 1.5 magnets, which is the difference between the quantity demanded and quantity supplied at \$2.00. A quota would distribute permits to refrigerator magnet producers for selling 7 refrigerator magnets. In a voluntary production reduction program, the government would pay refrigerator magnet producers to reduce their production from 8.5 magnets to 7 magnets per day.

    Now we must calculate the deadweight loss for each type of intervention: (use Figure 15.13 on p.558 of your textbook)

    Price floor:

    $DWL = \frac{1}{2}(8-7.5)(2.00-1.29) = 0.5325$ (\$1.29 is the price suppliers would charge if consumers would demand only 7 magnets)

    Price support program:

    $$DWL = 0.5325 + \frac{1}{2}(1.5-0.71)(1.5) + (0.71\times 1.5) + \frac{1}{2}(1.5-.33)(12-8.5) + \Lambda$$
    $$\Lambda + (12-8.5)(.33) + \frac{1}{2}(2-0.33)(12-8.5) = 10.36$$

Suppliers would produce 12 units if the price of magnets is \$2.00 and \$0.33 is the price consumers would like to pay if they were to buy 12 magnets.

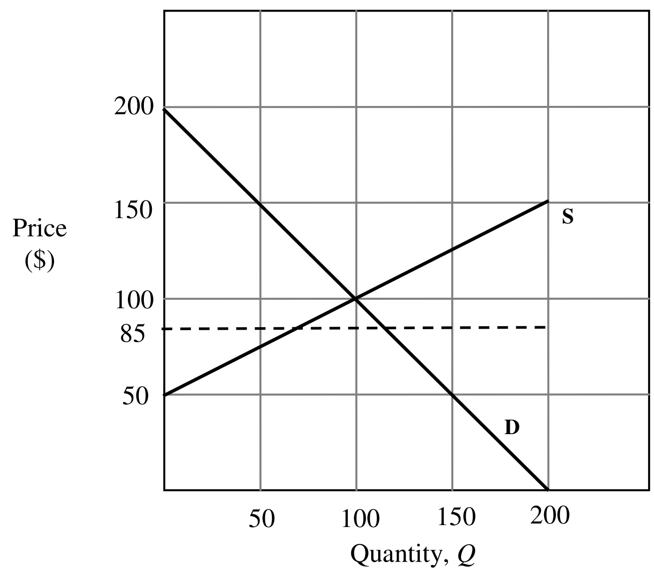
A quota program:

$$DWL = \tfrac{1}{2}(8-7.5)(2.00-1.29) = 0.5325$$

The voluntary reduction production program:

$$DWL = \tfrac{1}{2}(8-7.5)(2.00-1.29) = 0.5325$$

11. A price ceiling at \$85 for down blankets would restrict down blankets from being sold at a price below \$85. This would reduce the number of blankets produced by suppliers and the amount demanded. Since supply is less than demand, the amount supplied would determine the new equilibrium quantity



12. A tariff on imported sugar cane would decrease domestic aggregate surplus because they will now buy from less efficient (more expensive) producers of sugar because foreign suppliers will have offer consumers higher prices because of the tariff.

    A quota on imported sugar cane would decrease domestic aggregate surplus lower than a tariff would because with a quota the government does not receive any revenue; however, consumers and domestic firms would be exactly as well off with the quota as with the tariff.

13. The impact on social welfare would be in the form of a deadweight loss to consumers. Which may be calculated as follows (use Fig.15.18, on p.567 of the textbook):

$$DWL = \tfrac{1}{2}(1.5-1)(13-8) + \tfrac{1}{2}(1.5-1)(23-20.5) = 1.88$$

14. The impact on social welfare would be in the form of a deadweight loss to consumers. Which may be calculated as follows (use Fig.15.18, on p.567 of the textbook):

$$DWL = \tfrac{1}{2}(90-75)(80-50) + \tfrac{1}{2}(90-75)(125-110) = 337.5$$

15. The impact on social welfare would be in the form of a deadweight loss to consumers. Which may be calculated as follows (use Fig.15.18, on p.567 of the textbook):

$$DWL = \tfrac{1}{2}(6.75-5)(1.25-1) + \tfrac{1}{2}(10-9.25)(1.25-1) = .3125$$

Chapter 16

1. The difference between partial equilibrium analysis and general equilibrium analysis is that general equilibrium analysis focuses on the competitive equilibrium in many markets at the same time, as opposed to, partial equilibrium analysis which only considers the equilibrium in a single isolated market.

   The advantage of using general equilibrium analysis is that it allows economists to understand the consequences of interdependence in markets. Through the use of general equilibrium analysis economists can observe feedback between markets that have an effect on each other (i.e. market for crude oil and the market for automobiles).

2. A complete general analysis would require that we encompass every market in the world economy. For obvious reasons, such an endeavor would be impractical and very likely less informative than confusing.

3. First, notice that ice cream and cake are substitutes because the market-clearing curve is upward sloping. So, an increase in the price of ice cream would increase the demand for cake, which in turn increases the partial equilibrium price of cake.

4. First we must find the market clearing formulas for both pizza and hamburgers. This is done by equating supply and demand in each market.

   Pizza:

   $$34 - 2P_P - 2P_H = 10P_P - 2$$
   $$\Rightarrow P_P = 3 - \frac{P_H}{6} \quad (market-clearing\ \ function\ \ for\ \ pizza)$$

   Hamburgers:

   $$48 - 2P_P - 2P_H = 8P_P - 2$$
   $$\Rightarrow P_H = 4 - \frac{P_P}{6} \quad (market-clearing\ \ function\ \ for\ \ hamburgers)$$

   Next, we must solve for the prices that satisfy both market-clearing formulas at the same time. This is done by substituting one into the other, like so:

   $$P_P = 3 - \frac{1}{6}\left(4 - \frac{P_P}{6}\right)$$
   $$P_P = \frac{12}{5} = \$2.40$$

   The price of hamburgers is therefore,

   $$P_H = 4 - \frac{2.4}{6} = \$3.60$$

   Plugging these values into either the supply or demand function, we find that in the general equilibrium, consumers buy 22 million slices of pizza, and 28.8 million hamburgers.

If the government imposes a 35 cent tax per slice of pizza, this changes the supply function for pizza to:

$$P_P = 10(P - .35) - 2 = 10P - 5.5$$

Once again equate demand and supply in the pizza market to find:

$$34 - 2P_P - 2P_H = 10P_P - 5.5$$

$$\Rightarrow P_P = 3.29 - {P_H}/{6} \quad (market - clearing \;\; function \;\; for \;\; pizza)$$

We can now proceed as before, substituting P_H into P_P:

$$P_P = 3.29 - {1}/{6}\left(4 - {P_P}/{6}\right)$$

$$P_P = \$2.70$$

The price for hamburgers is thus:

$$P_H = 4 - {2.70}/{6} = \$3.55$$

Plugging these values into either the supply or demand function, we find that in the general equilibrium, consumers buy 21.5 million slices of pizza, and 26.4 million hamburgers.

5. First we must find the market clearing formulas for both deli turkey and roast beef. This is done by equating supply and demand in each market.

Deli Turkey:

$$34 - 2P_T - 4P_R = 10P_T - 2$$

$$\Rightarrow P_T = 3 - {P_R}/{3} \quad (market - clearing \;\; function \;\; for \; deli \; turkey)$$

Roast Beef:

$$58 - 4P_T + 4P_R = 8P_R - 2$$

$$\Rightarrow P_R = 5 - {P_T}/{3} \quad (market - clearing \;\; function \;\; for \; roast \, beef\,)$$

Next, we must solve for the prices that satisfy both market-clearing formulas at the same time. This is done by substituting one into the other, like so:

$$P_T = 3 - {1}/{3}\left(5 + {P_T}/{3}\right)$$

$$P_T = {54}/{30} = \$1.80$$

The price of roast beef is therefore,

$$P_R = 5 + {1.8}/{3} = \$5.60$$

Plugging these values into either the supply or demand function, we find that in the general equilibrium, consumers buy 16 million pounds of deli turkey meat, and 42.8 million pounds of roast beef.

If the government imposes a 48 cent tax per pound of turkey meat, this changes the supply function for deli turkey meat to:

$$P_T = 10(P - .48) - 2 = 10P - 6.8$$

Once again equate demand and supply in the deli turkey market to find:

$$34 - 2P_T - 4P_R = 10P_T - 6.8$$

$$\Rightarrow P_T = 3.4 - {}^{P_R}\!/_3 \quad (market-clearing\ \ function\ \ for\ deli\ turkey)$$

We can now proceed as before, substituting P_R into P_T:

$$P_T = 3.4 - {}^{1}\!/_3\left(5 + {}^{P_T}\!/_3\right)$$

$$P_T = \$1.56$$

The price for roast beef is thus:

$$P_R = 5 + {}^{1.56}\!/_3 = \$5.52$$

Plugging these values into either the supply or demand function, we find that in the general equilibrium, consumers buy 13.6 million pounds of deli turkey meat, and 42.16 million pounds of roast beef.

6. For an economy to be classified as Pareto efficient it resources must be allocated such that it is impossible to make any consumer better off without hurting someone else. Pareto efficiency can exist where one person owns 100% of all resources, because in such a scenario taking 1% of what that person owns and sharing it among the rest of society would make that one person worse off. It is important to remember that the notion of Pareto efficiency has nothing to do with equity.

7. The northeast boundary of this area (in other words the curve above) represents the utility possibilities frontier, which contains all the Pareto efficient allocations. Therefore, we can say that point A, B, and D are all Pareto efficient, but point C is not. It Marie and Jerry are starting off at point C then, we can make both better off by moving to point B.

8. Process-oriented notions of equity pay more attention to the procedures used to get to an allocation of resources, instead of on the allocation itself. On the other hand, outcome-oriented notions of equity focus on whether the process used to allocate resources gives fair outcomes. Process-oriented notions of equity are associated with a market-based system, because allocating resources by way of markets represents a process.

9. The main difference between utilitarianism and Rawlsianism is that utilitarianism says that society should place equal weight on the well-being of every individual. Whereas, Rawlsianism says that as a society we should place all weight on the well-being of its worst-off member.

The difficulty in implementing either outcome-oriented principle is that they both require that we know a person's cardinal utility; a feat that most economists agree is an unachievable objective. Standard utility theory is based on the fact that we may only know consumer's ordinal preferences (which bundle they prefer when compared to another bundle).

10. The first welfare theorem states that, in general equilibrium with perfect competition, the allocation of resources is Pareto efficient. An Edgeworth box shows two consumer's opportunities and choices in a single figure, there by allowing us to find a Pareto efficient outcome in an exchange economy.

11. The contract curve of an Edgeworth box identifies every efficient allocation of consumption goods. This turns out to be very useful because the contract curve shows every Pareto efficient outcome of consumption goods.

12. In any Pareto allocation, Marie's food consumption must equal her water consumption ($F_M = W_M$). If $F_M > W_M$, then we could transfer a small amount of food from Marie to Jerry, which would help Jerry without hurting Marie. If $F_M < W_M$, then we could transfer a small amount of water from Marie to Jerry, and produce a similar effect.

    Since a competitive equilibrium is Pareto efficient, Marie and Jerry must trade at a point on the contract curve. At every point on the curve, $F_J = W_J$, so Jerry's MRS_{FW} = 5 gallons per pound. We know that, in a competitive equilibrium, Jerry's $MRS_{FW} = P_W / P_F$, so we conclude that $P_W / P_F = 5$.

    To find the allocations to which Jerry and Marie will trade we need to use the budget line that goes through their endowment point. The slope of the budget line is $-P_W / P_F = -5$. If Jerry should want to increase his food consumption from 5 pounds to 6 pounds, he will have to reduce his water consumption by 5 gallons (from 5 to 0 gallons). This exchange will place him on the contract curve. This is the allocation that Marie and Jerry both wish to trade given their initial endowments and the equilibrium price ratio.

13. Marie's utility function is characteristic of goods that are deemed substitutable, thus Marie's food consumption does not have to equal her water consumption, but if the price of one good should increase in comparison to the price of the other good, she will consume less of that good and substitute it for the other good.

14. Input efficiency is the same as the concept of Pareto efficiency only that it applies to firms not consumers. It says that, holding constant the total amount of each input used in the economy, there is no way to increase any firm's output without decreasing the output of another firm.

    To have input efficiency it must hold, that for every pair of inputs, every pair of firms share the same *MRTS* (marginal technical rate of substitution).

15. The laissez-faire approach to efficiency proposes that government should not interfere with markets in the form of regulations, because markets are perfectly capable of correcting themselves. Any form of government intervention in markets would produce inefficiencies.

    The laissez-faire approach typically fails when there are market failures. Market failures are a source of inefficiency. Furthermore, real economies are hardly if ever perfectly competitive. The laissez-faire approach may also fail because it can produce inequitable results.

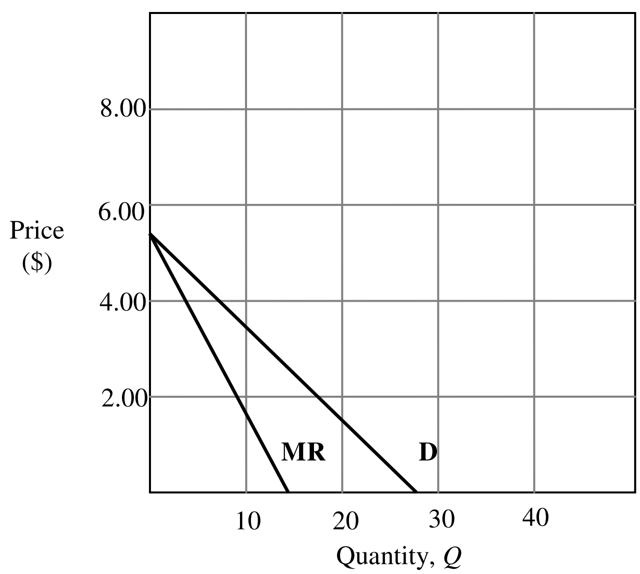
16. The second welfare theorem says that every Pareto efficient allocation is a competitive equilibrium for some initial allocation of resources. The second welfare theorem reflects an optimistic point of view in that it tells us that societies can use competitive markets to achieve both efficiency and equity.

Chapter 17

1. A firm that possesses market power is a firm that can profitably charge a price above its marginal cost. In a monopoly market there is only one seller, thus this monopolist firm would have possession of this market's power.

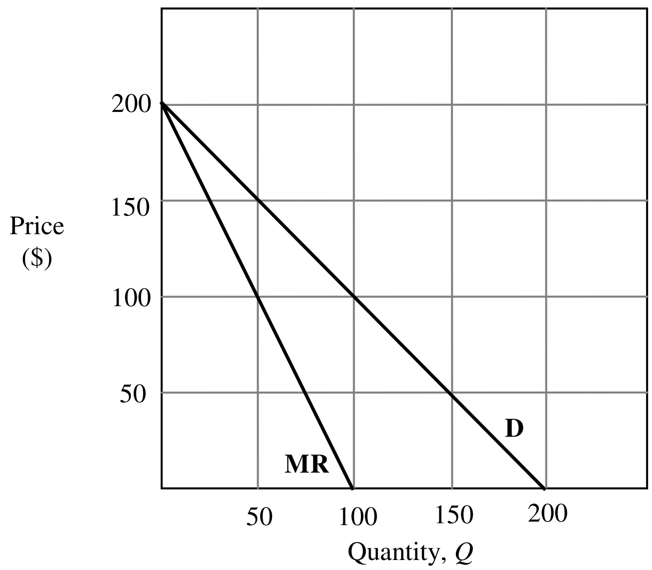
2. The monopolist will choose any positive quantity at which *MR* = *MC*. They will charge a price greater than or equal to average costs ($P \geq AC$). In a competitive equilibrium we would see a price that equal to the *MC* of the firm.

3. First find the inverse demand function, which is $P(Q) = 28/5 - Q/5$, so the $\Delta P/\Delta Q = -1/5$. Using the formula $MR = P(Q) + \left(\Delta P/\Delta Q\right)Q$, Boiler Pizza's marginal revenue when it sells *Q* slices of pizza is:
$$MR = \left(28/5 - Q/5\right) + \left(-1/5\right)Q$$
$$MR = 28/5 - 2Q/5$$
So Boiler Pizza's marginal revenue when it sells 5 slices is \$3.6. This is less than its price at 5 slices of pizza, which is $P(5) = 28/5 - (5)/5 = 4.6$.



4. First find the inverse demand function, which is $P(Q) = 200 - Q$, so the $\Delta P/\Delta Q = -1$.
Using the formula $MR = P(Q) + \left(\Delta P/\Delta Q\right)Q$, DownTown blankets marginal revenue when it sells *Q* down blankets is:
$$MR = (200 - Q) + (-1)Q$$
$$MR = 200 - 2Q$$

So DownTown blankets marginal revenue when it sells 100 blankets is \$0. This is less than its price at 100 blankets, which is $P(100) = 200 - (100) = \$100$.



5. In problem (3) we found that Boiler Pizza's inverse demand function is $P(Q) = 28/5 - Q/5$, and its marginal revenue is $MR = 28/5 - 2Q/5$. We can find its profit maximizing sales quantity and the associated price by applying the quantity rule and equating $MR = MC$:

$$MR = 28/5 - 2Q/5 = MC = 1/5 + Q/5$$
$$27/5 = 3Q/5$$
$$Q = 9$$

Now, we can substitute this quantity into the inverse demand function. Thus, we find the price associated with the profit maximizing quantity is

$$P(9) = 28/5 - 9/5 = \$3.80$$

We still need to check the shut-down rule. Observe that Boiler Pizza's profit is $\Pi = TR - TC = (9 \times 3.80) - \left(\left(1/5 \times 9\right) + (9)^2/10\right) = \$24.3$ *per hour*. Since Boiler Pizza earns nothing by shutting down, it will choose to operate at its profit-maximizing price of \$3.80.

6. In problem (4) we found that DownTown blankets' inverse demand function is $P(Q) = 200 - Q$, and its marginal revenue is $MR = 200 - 2Q$. We can find its profit maximizing sales quantity and the associated price by applying the quantity rule and equating $MR = MC$:

$$MR = 200 - 2Q = MC = 25 + Q/2$$
$$175 = 5Q/2$$
$$Q = 70$$

Now, we can substitute this quantity into the inverse demand function. Thus, we find the price associated with the profit maximizing quantity is

$$P(70) = 200 - (70) = \$130$$

We still need to check the shut-down rule. Observe that DownTown blankets' profit is $\Pi = TR - (VC + FC) = (70 \times 130) - \left(\left(25(70)\right) + (70)^2/4 + 5000 \right) = \$1125$. Since DownTown blankets will earn nothing by shutting down, it will prefer to operate at its profit-maximizing price of \$130.

7. The Lerner Index says that the markup is equal to $\frac{P - MC}{P}$. To use this index we need to find the *MC (500)*, which is 7.5. Therefore the mark-up is:

$$\frac{10 - 7.5}{10} = .25 \text{ } or \text{ } 25\%$$

To find the elasticity of demand ε^d, use the fact that $\frac{P - MC}{P} = -\frac{1}{\varepsilon^d}$. Thus, in our example is $\varepsilon^d = -\frac{1}{mark - up} = -\frac{1}{.25} = -4$.

8. The Lerner Index says that the markup is equal to $\frac{P - MC}{P}$. To use this index we need to find the *MC (8,500)*, which is 36. Therefore the mark-up is:

$$\frac{55 - 36}{55} = .345 \text{ } or \text{ } 34.5\%$$

To find the elasticity of demand ε^d, use the fact that $\frac{P - MC}{P} = -\frac{1}{\varepsilon^d}$. Thus, in our example is $\varepsilon^d = -\frac{1}{mark - up} = -\frac{1}{.345} = -2.90$.

9. To calculate the deadweight loss we need to first calculate the competitive equilibrium price and quantity. This can be found by setting equating marginal cost and the demand function for pizza.

$$MC = 1/5 + Q/5 = P = 28/5 - Q/5$$
$$2Q/5 = 27/5$$
$$Q = 13.5$$

Thus, price in the competitive equilibrium is:

$$P(13.5) = {}^{28}\!/_{5} - {}^{13.5}\!/_{5} = \$2.90$$

From question (5) we retrieve that the monopolistic profit-maximizing equilibrium is Q = 9 and P = \$3.80. We are now set to find the deadweight loss (Note: this is a simple matter in this example because the MC curve and demand curve are linear functions).

10. To calculate the deadweight loss we need to first calculate the competitive equilibrium price and quantity. This can be found by setting equating marginal cost and the demand function for down blankets.

$$MC = 25 + {}^{Q}\!/_{2} = P = 200 - Q$$

$${}^{3Q}\!/_{2} = 175$$

$$Q = 116.67$$

Thus, price in the competitive equilibrium is:

$$P(116.67) = 200 - (116.67) = \$83.33$$

From question (5) we retrieve that the monopolistic profit-maximizing equilibrium is Q = 70 and P = \$130. We are now set to find the deadweight loss (Note: this is a simple matter in this example because the MC curve and demand curve are linear functions).

$$DWL = {}^{1}\!/_{2}(130 - 83.33)(116.67 - 70) = 1089.04$$

11. Rent seeking refers to the social waste that is the effort made in securing a monopoly. Rent seeking could result in losses beyond the standard deadweight loss of having a monopoly market if the monopoly had to use their anticipated monopoly profit to secure the monopoly.

12. To find Marty Mart's marginal expenditure, *ME*, first find the inverse supply function, and then evaluate how much they would have to pay to buy 2000 toaster ovens.

$$Q^S = 20P + 1000 \Leftrightarrow P^s(Q) = {}^{Q}\!/_{20} - 50$$

Thus, to buy 2000 toaster ovens, Marty Mart would pay:

$$P^s(2000) = {}^{(2000)}\!/_{20} - 50 = 50$$

Since ${}^{\Delta P}\!/_{\Delta Q} = {}^{1}\!/_{20}$ for this inverse supply function, Marty Mart's marginal expenditure is

$$ME = P(Q) + \left(\Delta P \big/ \Delta Q\right) Q = \left(Q \big/ 20 - 50\right) + \left(1 \big/ 20\right) Q$$

$$ME = -50 + Q \big/ 10$$

So Marty Mart's marginal expenditure when it buys 2000 toaster ovens is $150, which is $100 more than it must pay for to buy the 2000 toaster ovens.

13. To find Marty Mart's marginal expenditure, *ME*, first find the inverse supply function, and then evaluate how much they would have to pay to buy 2000 toaster ovens.

$$Q^S = 10P + 1200 \Leftrightarrow P^s(Q) = Q \big/ 10 - 120$$

Thus, to buy 2000 toaster ovens Marty Mart would pay:

$$P^s(2000) = (2000) \big/ 10 - 120 = 80$$

Since $\Delta P \big/ \Delta Q = 1 \big/ 10$ for this inverse supply function, Marty Mart's marginal expenditure is

$$ME = P(Q) + \left(\Delta P \big/ \Delta Q\right) Q = \left(Q \big/ 10 - 120\right) + \left(1 \big/ 10\right) Q$$

$$ME = -120 + Q \big/ 5$$

So Marty Mart's marginal expenditure when it buys 2000 toaster ovens is $280, which is $200 more than it must pay to buy the 2000 toaster ovens.

14. To find the profit-maximizing number of toasters we need to derive the marginal benefit, which is given by the value of the inverse demand for toaster ovens. Since the demand curve is $Q^d = 1500 - 5P$, then the inverse demand is $MB = P = 300 - Q \big/ 5$. Now, we can proceed and find the profit-maximizing number of toaster ovens by setting *MB* = *ME* (from problem #12 we know $ME = -50 + Q \big/ 10$):

$$MB = P = 300 - Q \big/ 5 = ME = -50 + Q \big/ 10$$
$$Q = 1166.67$$

The price to buy 1750 toaster ovens can be found by using the inverse demand function:

$$P = 300 - 1166.67 \big/ 5 = \$66.67$$

The price and quantity in a competitive equilibrium could be found by equating supply and demand:

$$Q^S = 20P + 1000 = Q^d = 1500 - 5P$$
$$P = \$20.00$$
$$\Rightarrow Q = 1500 - 5(20) = 1400$$

15. To find the profit-maximizing number of toasters we need to derive the marginal benefit, which is given by the value of the inverse demand for toaster ovens. Since the demand curve is $Q^d = 2000 - 10P$, then the inverse demand is $MB = P = 200 - Q^d/10$. Now, we can proceed and find the profit-maximizing number of toaster ovens by setting *MB* = *ME* (from problem #13 we know $ME = -120 + Q/5$):

$$MB = P = 200 - Q^d/10 = ME = -120 + Q/5$$
$$Q = 1066.67$$

The price to buy 1066.67 toaster ovens can be found by using the inverse demand function:

$$P = 200 - 1066.67/10$$
$$P = \$93.33$$

The price and quantity in a competitive equilibrium could be found by equating supply and demand:

$$Q^S = 10P + 1200 = Q^d = 2000 - 10P$$
$$P = \$40$$
$$\Rightarrow Q = 2000 - 10(40) = 1600$$

16. A natural monopoly is a market whose good is produce most economically by a single firm.

Using a first-best solution the government would make the natural monopoly charge the competitive price, thereby maximizing aggregate surplus. The first-best solution is not typically used in practice because it is difficult to asses a firm's marginal cost; furthermore, pricing at the competitive price could lose the firm money.

Using a second-best solution the government would make the natural monopoly price at a level that would allow for the most aggregate surplus while allowing the monopolist to at least break even.

Chapter 18

1. Perfect price discrimination is what can occur if a monopolist knows each consumer's willingness to pay for each unit he sells, and is thus able to charge different prices for each unit. This is just about impossible to do because of the sheer amount of access to personal information on each consumer a firm would need. Firms are always trying to obtain more about their consumers, but perfect price discrimination is more of a theoretical possibility rather than an actual possibility.

2. A two-part tariff is a tariff in which consumers pay a fixed fee if they buy anything at all, plus a separate per-unit price for each unit they buy. An example of this would be bulk vendors charge a membership fee to shop at their stores.

   As is evident from the definition two-part tariffs have a separate per-unit price for each unit purchased. But this is just a special case of quantity-dependent pricing for which the price a consumer pays for an extra unit depends on how many units the consumer has bought. Two-part tariff is the same as the quantity-dependent pricing except for the extra part of a fixed fee.

3. A firm would like consumers with the low elasticity of demand to pay a higher price because they are more likely to accept increase in prices, because of their inelastic demand. This is like the example of the business traveler who has to travel on a moments notice and can't afford to look for a bargain.

4. To answer this question we first must solve for the quantity demand of each consumer at the competitive equilibrium (P = MC). Each consumer will demand $Q^d = 120 - 25(1.50) = 82.5$. To calculate consumer surplus we need the inverse demand function $\left[P = 4.8 - Q/25\right]$. Consumer surplus is \$136.125 which can be calculated taking a height of 4.8 minus 1.5 and multiplying by the base 82.5 times one-half (area of a triangle).

   The consumer surplus represents the maximum amount that a monopolist firm could set a two-part tariff at. Any amount past \$136.125 will cause the consumer to demand less quantity. Also, at a tariff of \$136.125 Dolly will not be able to charge for a subsequent fills of there special tube. Therefore, Dolly's profit will be 200 times the amount of consumer surplus or the two-part tariff, \$27,225.

5. To answer this question we first must solve for the quantity demand of each consumer at the competitive equilibrium (P = MC). Each consumer will demand $Q^d = 80 - 15(0.50) = 72.5$. To calculate consumer surplus we need the inverse demand function $\left[P = 5.33 - Q/15\right]$. Consumer surplus is \$175.09 which can be calculated taking a height of 5.33 minus 0.5 and multiplying by the base 72.5 times one-half (area of a triangle).

The consumer surplus represents the maximum amount that a monopolist firm could set a two-part tariff at. Any amount past \$175.09 will cause the consumer to demand less quantity. Also, at a tariff of \$175.09 Dolly will not be able to charge for a subsequent fills of there special tub. Therefore, Dolly's profit will be 200 times the amount of consumer surplus or the two-part tariff, \$35,018.

6. Let's first find the profit maximizing price for both single and multiple-cat owners. To do this we will need the inverse demands of both functions to help us find their respective marginal revenue functions. As we have seen before, a profit maximizing monopolist will set marginal revenue equal to marginal cost.

Single-cat owners:

Inverse demand is: $P = 5 - Q/2$. To find marginal revenue, use the equation, $MR = P_S + \left(\Delta P_S / \Delta Q\right)Q$, and substitute the inverse demand function as follows: $MR = \left(5 - Q/2\right) + \left(-1/2\right)Q = 5 - Q$. Next, equate marginal revenue and marginal cost.

$$5 - Q = 2.00 \Leftrightarrow Q = 3 \quad \& \quad P = 5 - 3/2 = \$3.5$$

So Dolly will sell 3lbs of food to each single-cat owner at a price of \$3.50. Profit from single-cat owners will be $(3.50 - 2)(3) = \$4.5$ per consumer.

Multiple-cat owners:

Inverse demand is: $P = 6 - Q/3$. To find marginal revenue, use the equation, $MR = P_M + \left(\Delta P_M / \Delta Q\right)Q$, and substitute the inverse demand function as follows: $MR = \left(6 - Q/3\right) + \left(-1/3\right)Q = 6 - 2Q/3$. Next, equate marginal revenue and marginal cost.

$$6 - 2Q/3 = 2.00 \Leftrightarrow Q = 6 \quad \& \quad P = 6 - 2(6)/3 = \$2.00$$

So Dolly will sell 6lbs of food to each multiple-cat owner at a price of \$2.00. Profit from single-cat owners will be $(4 - 2)(6) = \$12$ per consumer.

Now, to calculate Dolly's profits without price discrimination, we must first find the following: market demand, inverse market demand, and marginal revenue. Market demand is simply the sum of the multiple and single-cat owner demand functions after a certain price.

$$Q^d = \begin{cases} 18 - 3P \;\; for \;\; P > 5 \\ 28 - 5P \;\; for \;\; P \leq 5 \end{cases}$$

Inverse market demand is:

$$P = \begin{cases} 6 - Q/3 & for\ Q < 3 \\ 28/5 - Q/5 & for\ Q \geq 3 \end{cases}$$

It follows that the marginal revenue is:

$$MR = \begin{cases} 6 - 2Q/3 & for\ Q < 3 \\ 28/5 - 2Q/5 & for\ Q \geq 3 \end{cases}$$

Now we must solve for profit, first find profit-maximizing price and quantity (MR = MC):

If $Q < 3$:

$6 - 2Q/3 = 2 \Leftrightarrow Q = 6 \quad P = 6 - 6/3 = \$4$. Then profit is, $(4-2) \times 6 = \$12$.

If $Q \geq 3$:

$28/5 - Q/5 = 2 \Leftrightarrow Q = 9 \quad P = 28/5 - 9/5 = \$3.80$. Then profit is, $(3.80 - 2) \times 9 = \$16.2$.

The profit-maximizing price that Dolly would charge both single and multiple-cat owners without price discrimination is \$3.80. Looking at both maximum profit outcomes (with price discrimination and without price discrimination) we see that Dolly's profit was higher with price discrimination (16.5 > 16.2).

7. We found in the previous problem that price discrimination hurts multiple-cat owners by increasing the price, but single-cat owners are helped by a lowering of the price.

   The gain for single-cat owners is equal to the area of the trapezoid with height 3.80 minus 3.50, and one base equal to 2.4, while the other base is equal to 3 minus 2.4. This yields a consumer surplus of,

   $$CS_S = (3.80 - 3.50)(2.4) + (3.8 - 3.5)(3 - 2.4)\left(1/2\right) = 0.81.$$

   The loss in consumer surplus to multiple-cat owners is equal to the area of the trapezoid with height 4 minus 3.8, and one base equal to 2.4, and the other base equal to 6.6 minus 6. This yields a consumer surplus of,

   $$CS_M = (4 - 3.80)(6) + (6.6 - 6)(4 - 3.80)\left(1/2\right) = 1.26$$

   The total net loss on consumer surplus due to the use of price discrimination is $1.26 - 0.81 = 0.45$. The gain in profit, as we found in the previous problem, was 0.3. So we can conclude that price discrimination lowers aggregate surplus by 0.15 $(0.45 - 0.3)$.

8. Let's first find the profit maximizing price for both hot and cold days. To do this we will need the inverse demands of both functions to help us find their respective marginal revenue functions. As we have seen before, a profit maximizing monopolist will set marginal revenue equal to marginal cost.

Hot days:

Inverse demand is: $P = 150 - 50Q$. To find marginal revenue, use the equation, $MR = P_H + \left({}^{\Delta P_H}\!/\!{}_{\Delta Q} \right) Q$, and substitute the inverse demand function as follows: $MR = (150 - 50Q) + (-50)Q = 150 - 100Q$. Next, equate marginal revenue and marginal cost.

$$150 - 100Q = 0.20 \Leftrightarrow Q = 1.50 \quad \& \quad P = 150 - 100(1.50) = 75 \textit{ cents}$$

So JP-Cola will sell 1.50 cans of soft drink on each hot day at a price of \$0.75. Profit from hot days will be $(0.75 - 0.20)(1.5) = \$0.825$ per consumer.

Cold days:

Inverse demand is: $P = 100 - 50Q$. To find marginal revenue, use the equation, $MR = P_M + \left({}^{\Delta P_M}\!/\!{}_{\Delta Q} \right) Q$, and substitute the inverse demand function as follows: $MR = (100 - 50Q) + (-50)Q = 100 - 100Q$. Next, equate marginal revenue and marginal cost.

$$100 - 100Q = 0.20 \Leftrightarrow Q = 0.998 \quad \& \quad P = 100 - 100(.998) = 50.1 \textit{ cents}$$

So JP-Cola will sell about 0.998 can of soda on each cold day at a price of \$0.501. Profit from hot-cat days will be $(.501 - 0.20)(0.998) = \$0.30$ per consumer.

Now, to calculate JP-Cola's profits without price discrimination, we must first find the following: market demand, inverse market demand, and marginal revenue. Market demand is simply the sum of the cold and hot day demand functions after a certain price.

$$Q^d = \begin{cases} 3 - 0.02P \ \textit{for} \ P > 50 \\ 5 - 0.04P \ \textit{for} \ P \le 50 \end{cases}$$

Inverse market demand is:

$$P = \begin{cases} 150 - 50Q \ \textit{for} \ Q < 1 \\ 125 - 25Q \ \textit{for} \ Q \ge 1 \end{cases}$$

It follows that the marginal revenue is:

$$MR = \begin{cases} 150 - 100Q \ \textit{for} \ Q < 1 \\ 125 - 50Q \ \textit{for} \ Q \ge 1 \end{cases}$$

Now we must solve for profit, first find profit-maximizing price and quantity (MR = MC):

If $Q < 1$:
$150 - 100Q = 0.2 \Leftrightarrow Q = 1.50 \quad P = 150 - 50(1.50) = \$0.75$. Then profit is,
$(0.75 - 0.2) \times 1.5 = \$0.825$.

If $Q \geq 1$:
$125 - 50Q = 0.2 \Leftrightarrow Q = 2.496 \quad P = 125 - 25(2.496) = \$0.626$. Then profit is,
$(0.626 - 0.20) \times 2.496 = \$1.06$.

If JP-Cola could only charge one price, knowing that it will be hot 5 days and cold 5 days, it should price of $0.626, which is the non-price discriminatory level.

The profit-maximizing price that JP-Cola would charge both hot and cold days without price discrimination is $0.626. Looking at both maximum profit outcomes (with price discrimination and without price discrimination) we see that JP-Cola's profit was higher with price discrimination (1.125 > 1.06).

9. We found in the previous problem that price discrimination hurts consumers on hot days because it increases the price, but consumers on cold days are helped by a lowering of the price. The gain for cold day consumers is equal to the area of the trapezoid with height 0.626 subtract 0.501, and one base equal to 1.987, while the other base is equal to 1.989 subtract 1.987 (note: to get the numbers for the base we simply plug-in the prices ex-post and ex-ante of price discrimination with concerns to cold day consumers). This yields a consumer surplus of,
$$CS_C = (0.626 - 0.501)(1.987) + (0.626 - 0.501)(1.989 - 1.987)\left(\tfrac{1}{2}\right) = 0.2485.$$
The loss in consumer surplus consumers on hot day is equal to the area of the trapezoid with height 0.75 minus 0.626, and one base equal to 2.985, and the other base equal to 2.987 minus 2.985. This yields a loss of consumer surplus of,
$$CS_H = (0.75 - 0.626)(2.985) + (0.75 - 0.626)(2.987 - 2.985)\left(\tfrac{1}{2}\right) = .3703$$
The total net loss on consumer surplus due to the use of price discrimination is $0.3703 - 0.2485 = 0.1218$. The gain in profit, as we found in the previous problem, was 0.065. So we can conclude that price discrimination lowers aggregate surplus by, $[\textit{Loss in consumer surplus} - \textit{profit increase} = 0.1218 - 0.065 = 0.0568]$.

10. Yes it could under specific circumstances. Price discrimination may encourage a monopolist to produce or supply more of a good, since without price discrimination they would sell to few tickets. This could increase aggregate surplus. In a similar fashion this could also increase consumer surplus.

11. The table below shows four different per pound prices, the quantities purchased by each type of consumer, the fixed fee, the profits form sales to each type of consumer, and the total profit.

    To calculate the quantity at a certain price just plug in the price into the corresponding demand function that was given. The fixed fee is the same as the quantity of single-cat owner consumer surplus. Profits per type of consumer are calculated by multiplying the specific price and quantity, then adding the fixed fee and finally subtracting the marginal cost times the number of pounds purchased. To find total profit, take the profit for each type of consumer and aggregate it across the whole market (i.e. all single-cat owners and multiple-cat owner).

    According to the chart below the most profitable price for Dolly to charge would be $2.00 earning them a profit of $3,900.

Price per pound

	$1.00	**$1.50**	**$2.00**	**$2.50**
Pounds purchased				
Single-cat owner	8	7	6	5
Multiple-cat owner	15	13.5	12	10.5
Fixed fee ($):	$16	$12.25	$9	$6.25
Profits ($):				
Single-cat owner	$8	$8.75	$15	$8.75
Multiple-cat owner	$16	$5.5	$9	$11.50
Total profit ($):	$3,200	$2,300	$3,900	$2,900

12. The table below shows four different per pound prices, the quantities purchased by each type of consumer, the fixed fee, the profits form sales to each type of consumer, and the total profit.

    To calculate the quantity at a certain price just plug in the price into the corresponding demand function that was given. We should note that there is cap on how much the low-demand consumers can purchase. The fixed fee for low-demand consumers is the same as in the previous problem, however, we now have to calculate the fixed fee charged to high-demand consumers (multiple-cat owners).

    Refer to Figure 18.12 (p.692) in your textbook to see how the new fixed fee for high-demand consumers is calculated. Profits per type of consumer are calculated by multiplying the specific price and quantity, then adding the fixed fee and finally subtracting the marginal cost times the number of pounds purchased. To find total profit, take the profit for each type of consumer and aggregate it across the whole market (i.e. all single-cat owners and multiple-cat owner).

According to the chart below the most profitable price for Dolly to charge would be $2.50 per pound to single-cat owners, and $2.00 per pound to multiple-cat owners earning them a total profit of $4,832.

		Price per pound		
	$1.50	**$2.00**	**$2.50**	**$3.00**
Pounds purchased				
Single-cat owner	6(capped)	6	5	4
Multiple-cat owner	12	12	12	12
Fixed fee ($):				
Low-demand plan	$16	$12.25	$9	$6.25
High-demand plan	$15	$22.125	$25.32	$31.35
Profits ($):				
Single-cat owner	$13	$12.25	$11.50	$6.25
Multiple-cat owner	$15	$22.125	$25.32	$31.35
Total profit ($):	$4,100	$4,662.50	$4,832	$4,385

13. The table below shows four different per pound prices, the quantities purchased by each type of consumer, the fixed fee, the profits form sales to each type of consumer, and the total profit.

    To calculate the quantity at a certain price just plug in the price into the corresponding demand function that was given. The fixed fee is the same as the quantity of single-cat owner consumer surplus. Profits per type of consumer are calculated by multiplying the specific price and quantity, then adding the fixed fee and finally subtracting the marginal cost times the number of pounds purchased. To find total profit, take the profit for each type of consumer and aggregate it across the whole market (i.e. all single-cat owners and multiple-cat owner).

    According to the chart below, the most profitable price for Dolly to charge would be $2.00 earning them a profit of $5,700.

	Price per pound			
	$1.00	**$1.50**	**$2.00**	**$2.50**
Pounds purchased				
Single-cat owner	8	7	6	5
Multiple-cat owner	15	13.5	12	10.5
Fixed fee ($):	$16	$12.25	$9	$6.25
Profits ($):				
Single-cat owner	$8	$8.75	$15	$8.75
Multiple-cat owner	$16	$5.5	$9	$11.50
Total profit ($):	$6,400	$3,400	$5,700	$5,200

14. The table below shows four different per pound prices, the quantities purchased by each type of consumer, the fixed fee, the profits form sales to each type of consumer, and the total profit.

    To calculate the quantity at a certain price just plug in the price into the corresponding demand function that was given. We should note that there is cap on how much the low-demand consumers can purchase. The fixed fee for low-demand consumers is the same as in the previous problem, however, we now have to calculate the fixed fee charged to high-demand consumers (multiple-cat owners).

    Refer to Figure 18.12 (p.692) in your textbook to see how the new fixed fee for high-demand consumers is calculated. Profits per type of consumer are calculated by multiplying the specific price and quantity, then adding the fixed fee and finally subtracting the marginal cost times the number of pounds purchased. To find total profit, take the profit for each type of consumer and aggregate it across the whole market (i.e. all single-cat owners and multiple-cat owner).

    According to the chart below, the most profitable price for Dolly to charge would be $3.00 per pound to single-cat owners, and $2.00 per pound to multiple-cat owners earning them a total profit of $4,832.

Price per pound

	$1.50	**$2.00**	**$2.50**	**$3.00**
Pounds purchased				
Single-cat owner	6(capped)	6	5	4
Multiple-cat owner	12	12	12	12
Fixed fee ($):				
Low-demand plan	$16	$12.25	$9	$6.25
High-demand plan	$15	$22.125	$25.32	$31.35
Profits ($):				
Single-cat owner	$13	$12.25	$11.50	$6.25
Multiple-cat owner	$15	$22.125	$25.32	$31.35
Total profit ($):	$7,100	$9087.5	$9,896	$10,655

15. Bundling is the practice of selling several products together as package. Firms can use bundling to extract additional consumer surplus because different consumers' willingness to pay for products that are negatively related. A monopolist will use bundling to eliminate the variation in consumer valuations, allowing the monopolist to extract the entire aggregate surplus as profit.

Chapter 19

1. The Nash equilibrium in a Bertrand oligopoly model is at $P = MC$. At any price above MC a firm won't sell any output because they will be under-cut by other another firm(s) that will price at MC. At any price below MC the firm will sell its output but will lose money because P > MC. All that is needed in a single market for this to happen is two firms.

2. The Cournot-oligopoly model involves firms choosing quantities simultaneously. In the Bertrand model we saw that if a firm priced above their marginal cost they would be under-cut by another firm, and as a result would not sell any units. However, the previous scenario is contingent on the assumption that the under-cutting firm has produced enough to supply all of the demand in the market. This is not usually the case because a firm can only sell a only a limited amount of quantity at one time. This suggests the existence of a capacity constraint.

3. In a Bertrand model the equilibrium price equal to marginal cost. In this case it is \$20. To find the equilibrium quantity set P = MC.

$$MC = 20 \overset{set}{=} P = 50 - Q/10$$
$$Q = 300$$

Thus, 300 handbags will be bought and sold at a price of \$20 in this market. Since, both Kristen and Megan are pricing the handbags at marginal cost they will earn \$0 in economic profit. To see this numerically calculate revenue, which is the price, multiplied by the quantity sold, which is \$6000 in this example. Now, we have to subtract marginal cost,\$20, times the number of units sold 300. Thus profit is \$6000 - \$6000 = 0.

4. In order to solve for the Nash equilibrium output there are several things which we must do first. The market inverse demand is $P = 50 - 0.1Q$. Given Kristin and Megan's outputs we find that the price is $P = 50 - 0.1(Q_K + Q_M)$. We can rewrite this expression in terms of residual demand as follows:

Kristin:
$P = (50 - 0.1Q_K) - 0.1Q_M$, and similarly

Megan:
$P = (50 - 0.1Q_M) - 0.1Q_K$.

Now we need to find Kristin and Megan's best-response function which entails that we find their respective marginal revenue functions as well as their profit maximizing output. Remember that $MR = P + \left(\Delta P / \Delta Q\right) Q$.

Kristin:

$MR_K = (50 - 0.1Q_K - 0.1Q_M) - 0.1Q_K$

$MR_K = 50 - 0.2Q_K - 0.1Q_M$

Kristin's profit maximizing output can be found by setting MR = MC.

$\$20 = 50 - 0.2Q_K - 0.1Q_M$

$Q_K = 150 - 0.5Q_M$

Because of the symmetrical nature of the problem we can deduce without calculation that Megan's best-response function is $Q_M = 150 - 0.5Q_K$. (You can make sure this is so, as an exercise).

To find the Nash equilibrium quantity we substitute Kristin's best-response function into Megan's best-response function, or vice versa.

$Q_M = 150 - 0.5(150 - 0.5Q_M)$

$Q_M = 150 - 75 + 0.25Q_M$

$Q_M = 100$

Substitute this quantity into Kristin's best-response function and we find that $Q_K = 100$, which gives us the Nash equilibrium quantity.

Substitute the equilibrium quantity into the inverse market demand function $P = 50 - {}^{(100)}\!/_{10} = \$40$ which is the equilibrium price (notice that it is \$20 above the marginal cost). Thus both Megan and Kristin each make a profit of \$20 times 100 (quantity), which is \$2000.

5. In order to solve for the Nash equilibrium output there are several things which we must do first. The market inverse demand is $P = 50 - 0.1Q$. Given Kristin and Megan's outputs we find that the price is $P = 50 - 0.1(Q_K + Q_M)$. We can rewrite this expression in terms of residual demand as follows:

Kristin:

$P = (50 - 0.1Q_K) - 0.1Q_M$, and similarly

Megan:

$P = (50 - 0.1Q_M) - 0.1Q_K$.

Now we need to find Kristin and Megan's best-response function which entails that we find their respective marginal revenue functions as well as their profit maximizing output. Remember that $MR = P + \left({}^{\Delta P}\!/_{\Delta Q}\right)Q$.

Kristin:

$MR_K = (50 - 0.1Q_K - 0.1Q_M) - 0.1Q_K$

$MR_K = 50 - 0.2Q_K - 0.1Q_M$

Kristin's profit maximizing output can be found by setting MR = MC.

$\$30 = 50 - 0.2Q_K - 0.1Q_M$

$Q_K = 100 - 0.5Q_M$

Because of the symmetrical nature of the problem we can deduce without calculation that Megan's best-response function is $Q_M = 100 - 0.5Q_K$. (You can make sure this is so, as an exercise).

To find the Nash equilibrium quantity we substitute Kristin's best-response function into Megan's best-response function, or vice versa.

$Q_M = 100 - 0.5(100 - 0.5Q_M)$

$Q_M = 100 - 50 + 0.25Q_M$

$Q_M = 66.7$

Substitute this quantity into Kristin's best-response function and we find that $Q_K = 66.7$, which gives us the Nash equilibrium quantity.

Substitute the equilibrium quantity into the inverse market demand function $P = 50 - {}^{(66.7)}\!/_{10} = \$43.33$ which is the equilibrium price (notice that it is \$30 above the marginal cost). Thus both Megan and Kristin each make a profit of \$13.33 times 66.7 (quantity), which is \$890.04.

6. In order to solve for the Nash equilibrium output there are several things which we must do first. The market inverse demand is $P = 40 - 0.2Q$. Given Kristin and Megan's outputs we find that the price is $P = 40 - 0.2(Q_K + Q_M)$. We can rewrite this expression in terms of residual demand as follows:

Kristin:

$P = (40 - 0.2Q_K) - 0.2_M$, and similarly

Megan:

$P = (40 - 0.2Q_M) - 0.2Q_K$.

Now we need to find Kristin and Megan's best-response function which entails that we find their respective marginal revenue functions as well as their profit maximizing output. Remember that $MR = P + \left({}^{\Delta P}\!/_{\Delta Q}\right)Q$.

Kristin:

$$MR_K = (40 - 0.2Q_K - 0.2Q_M) - 0.2Q_K$$
$$MR_K = 40 - 0.4Q_K - 0.2Q_M$$

Kristin's profit maximizing output can be found by setting MR = MC.

$$\$10 = 40 - 0.4Q_K - 0.2Q_M$$
$$Q_K = 75 - 0.5Q_M$$

Because of the symmetrical nature of the problem we can deduce without calculation that Megan's best-response function is $Q_M = 75 - 0.5Q_K$. (You can make sure this is so, as an exercise).

To find the Nash equilibrium quantity we substitute Kristin's best-response function into Megan's best-response function, or vice versa.

$$Q_M = 75 - 0.5(75 - 0.5Q_M)$$
$$Q_M = 75 - 37.5 + 0.25Q_M$$
$$Q_M = 50$$

Substitute this quantity into Kristin's best-response function and we find that $Q_K = 50$, which gives us the Nash equilibrium quantity.

Substitute the equilibrium quantity into the inverse market demand function $P = 40 - {}^{(50)}\!/_{5} = \$30$ which is the equilibrium price (notice that it is \$10 above the marginal cost). Thus both Megan and Kristin each make a profit of \$10 times 50 (quantity), which is \$500.

7. There are a few steps we must do before we solve for the Nash equilibrium. First should rearrange the demand functions in a form that will better suit our analysis. The functions for Joe's and Bob's quantity demanded given above can be rewritten as follows.

$$Q_{Joe} = (150 + 100P_{Bob}) - 125P_{Joe}$$
$$Q_{Bob} = (150 + 100P_{Joe}) - 125P_{Bob}$$

Given this form above we can solve for both Joe's and Bob's inverse demand functions. They are

$$P_{Joe} = 1.2 + 0.8P_{Bob} - 0.008Q_{Joe}$$
$$P_{Bob} = 1.2 + 0.8P_{Joe} - 0.008Q_{Bob}$$

Now we proceed by finding Joe's best response function, which will involve deriving his marginal revenue (like we have done before), where $\Delta P/\Delta Q = -0.008$; and solving for the profit maximizing quantity.

$$MR_{Joe} = 1.2 + 0.8P_{Bob} - 0.016Q_{Joe}$$

Solving for the profit maximizing quantity requires that we set MR = MC.

$$MR_{Joe} = 1.2 + 0.8P_{Bob} - 0.016Q_{Joe} \overset{set}{=} 1$$

Rearranging terms will yield the profit-maximizing sales quantity

$$Q_{Joe} = 12.5 + 50P_{Bob}$$

Next, we should solve for the profit-maximizing sales price. To accomplish this we could simply substitute our profit-maximizing quantity into Joe's inverse demand function.

$$P_{Joe} = 1.2 + 0.8P_{Bob} - 0.008(12.5 + 50P_{Bob})$$
$$P_{Joe} = 1.1 + 0.4P_{Bob}$$

Again, we may use the symmetrical nature of the problem to conclude that Bob's best response function is $P_{Bob} = 1.1 + 0.4P_{Joe}$. If you feel that you need more practice you could derive Bob's profit-maximizing sales price in the same way we found Joe's.

Now, we can find the Nash equilibrium by substituting Joe's profit-maximizing sales price into Bob's profit-maximizing sales price, or vice a versa.

$$P_{Bob} = 1.1 + 0.4(1.1 + 0.4P_{Bob}) = 1.1 + 0.44 + 0.16P_{Bob}$$
$$P_{Bob} = \$1.83 \textit{ per hamburger}$$

Similarly, the Nash equilibrium price for Joe's is also $1.83 per hamburger.

To find what quantities will be sold by each stand we can substitute in our Nash equilibrium prices into our original demand function.

$$Q_{Joe} = (150 + 100(1.83)) - 125(1.83) = 104.25$$
$$Q_{Bob} = (150 + 100(1.83)) - 125(1.83) = 104.25$$

To find how much profit will be made by each stand take the difference between the equilibrium price and the marginal cost (0.83), and then multiply by the equilibrium quantity (104.25) which will yield each stand a profit of about $86.53.

8. There are a few steps we must do before we solve for the Nash equilibrium. First should rearrange the demand functions in a form that will better suit our analysis. The functions for Joe's and Bob's quantity demanded given above can be rewritten as follows.

$$Q_{Joe} = (150 + 300P_{Bob}) - 325P_{Joe}$$
$$Q_{Bob} = (150 + 300P_{Joe}) - 325P_{Bob}$$

Given this form above we can solve for both Joe's and Bob's inverse demand functions. They are

$$P_{Joe} = 0.46 + 0.92P_{Bob} - 0.003Q_{Joe}$$
$$P_{Bob} = 0.46 + 0.92P_{Joe} - 0.003Q_{Bob}$$

Now we proceed by finding Joe's best response function, which will involve deriving his marginal revenue (like we have done before), where $\Delta P / \Delta Q = -0.003$; and solving for the profit maximizing quantity.

$$MR_{Joe} = 0.46 + 0.92 P_{Bob} - 0.006 Q_{Joe}$$

Solving for the profit maximizing quantity requires that we set MR = MC.

$$MR_{Joe} = 0.46 + 0.92 P_{Bob} - 0.006 Q_{Joe} \overset{set}{=} 1$$

Rearranging terms will yield the profit-maximizing sales quantity

$$Q_{Joe} = 90 + 153.33 P_{Bob}$$

Next, we should solve for the profit-maximizing sales price. To accomplish this we could simply substitute our profit-maximizing quantity into Joe's inverse demand function.

$$P_{Joe} = 0.46 + 0.92 P_{Bob} - 0.003(90 + 153.33 P_{Bob})$$

$$P_{Joe} = -0.19 + 0.46 P_{Bob}$$

Again, we may use the symmetrical nature of the problem to conclude that Bob's best response function is $P_{Bob} = -0.19 + 0.46 P_{Joe}$. If you feel that you need more practice you could derive Bob's profit-maximizing sales price in the same way we found Joe's.

Now, we can find the Nash equilibrium by substituting Joe's profit-maximizing sales price into Bob's profit-maximizing sales price, or vice a versa.

$$P_{Bob} = -0.19 + 0.46(-0.19 + 0.46 P_{Bob}) = -0.19 - 0.09 + 0.21 P_{Bob}$$

$$P_{Bob} = \$0.35 \textit{ per hamburger}$$

Similarly, the Nash equilibrium price for Joe's is also \$0.35 per hamburger.
To find what quantities will be sold by each stand we can substitute in our Nash equilibrium prices into our original demand function.

$$Q_{Joe} = (150 + 300(0.35)) - 325(0.35) = 141.25$$

$$Q_{Bob} = (150 + 300(0.35)) - 325(0.35) = 141.25$$

To find how much profit will be made by each stand take the difference between the equilibrium price and the marginal cost (-0.65), and then multiply by the equilibrium quantity (141.25) which will yield each stand a negative profit of about -\$91.81.

9. Kristen will not undercut Megan as long as the following holds:

$$\underbrace{5{,}000}_{\textit{This months gain}} \leq \underbrace{5{,}000\left(\frac{1}{R}\right)}_{\textit{Present discounted value of future loss}}$$

Equivalently, the inequality above can be expressed by, $R \leq 1$. The 1 indicates an interest rate of 100%, meaning that Kristen will not undercut Megan unless the interest rate was 100% or higher.

10. Kristen will not undercut Megan as long as the following holds:

$$\underbrace{8{,}000}_{\text{This months gain}} \quad \le \quad \underbrace{8{,}000\left(\frac{1}{R}\right)}_{\text{Present discounted value of future loss}}$$

Equivalently, the inequality above can be expressed by, $R \le 1$. The 1 indicates an interest rate of 100%, meaning that Kristen will not undercut Megan unless the interest rate was 100% or higher.

11. The difference between tacit collusion and explicit collusion is that in the former case colluding firms communicate with each other and have understood agreements, whereas tacit collusion colluding firms do not communicate but an understanding is reached implicitly.

    Tacit collusion between firms is harder to maintain because they are made without communication, which makes a mutual understanding between colluding firms very difficult to achieve.

12. Business stealing is what can happen when a firm enters a market and its sales come at the expense of existing firms. The problem with business stealing is that it can produce too much incentive for new firms to enter the market, because new firms are not only profiting from there own output but it is also profiting from sales that it takes from existing firms.

13. Recall Kristin's inverse residual demand function from question 4.

$$P = (50 - 0.1Q_K) - 0.1Q_M$$

Also, recall Megan's best response function from question 4.

$$Q_M = 150 - 0.5Q_K$$

If we substitute Megan's best response function into Kristin's inverse residual demand function, the result will be a formula that describes the price Kristin's receives at each level of output, while taking into account what Megan's best response will be to her choice:

$$P = (50 - 0.1Q_K) - 0.1(150 - 0.5Q_K)$$

$$P = 35 - 0.05Q_K$$

From this relationship, Kristin can derive her marginal revenue, which is:

$$MR = P + (\Delta P/\Delta Q)Q$$

$$MR = 35 - 0.05Q_K + -0.05Q_K$$

$$MR = 35 - 0.1Q_K$$

Kristin will maximize her profit by choosing the output level Q_K equates her marginal revenue with her marginal cost:

$$20 = 35 - 0.1Q_K$$
$$Q_K = 150$$

Megan's best response to this output is $Q_M = 150 - 0.5(150) = 75$. At a total output of 225 handbags the market price is \$27.50. Kristin's profit is \$1,125 which is \$875 less than what she made if the two chose their inputs simultaneously, while Megan profits \$562.50 (\$1437.50 less than in the Cournot example).

14. Recall Kristin's inverse residual demand function from question 4.

$$P = (40 - 0.2Q_K) - 0.2_M$$

Also, recall Megan's best response function from question 4.

$$Q_M = 75 - 0.5Q_K$$

If we substitute Megan's best response function into Kristin's inverse residual demand function, the result will be a formula that describes the price Kristin's receives at each level of output, while taking into account what Megan's best response will be to her choice:

$$P = (40 - 0.2Q_K) - 0.2(75 - 0.5Q_K)$$
$$P = 25 - 0.1Q_K$$

From this relationship, Kristin can derive her marginal revenue, which is:

$$MR = P + (\Delta P/\Delta Q)Q$$
$$MR = 25 - 0.1Q_K + -0.1Q_K$$
$$MR = 25 - 0.2Q_K$$

Kristin will maximize her profit by choosing the output level Q_K equates her marginal revenue with her marginal cost:

$$10 = 25 - 0.2Q_K$$
$$Q_K = 75$$

Megan's best response to this output is $Q_M = 75 - 0.5(75) = 37.5$. At a total output of 112.5 handbags the market price is \$17.50. Kristin's profit is \$562.5 which is \$62.5 more than what she made if the two chose their inputs simultaneously, while Megan profits \$281.25 (\$218.75 less than in the Cournot example).

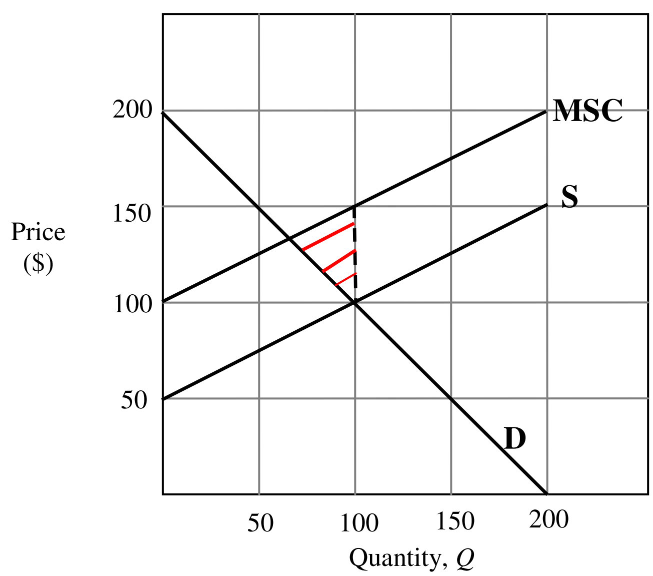
15. A horizontal merger is occurs when two or more competing firms merge (that is combine) their operations, and become one firm. A horizontal merger would be more effective than fixing prices because fixing prices involves an agreement between two firms that must be enforced in order to properly fix a price. A horizontal merger between the firms that were looking to fix prices would simplify the desired outcome greatly.

Chapter 20

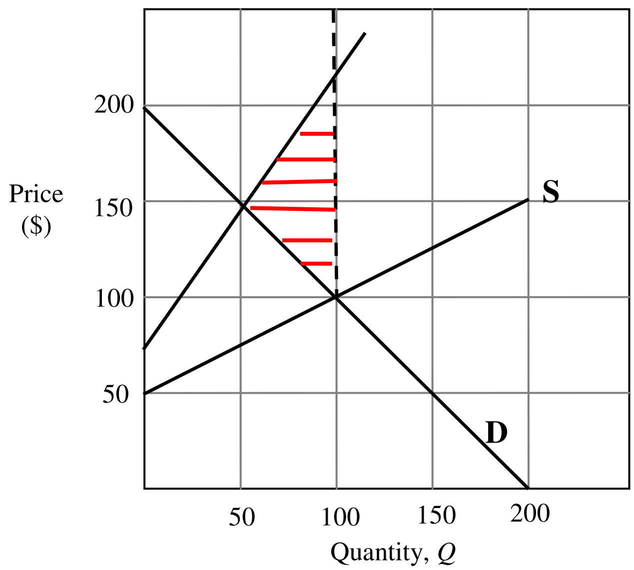
1. When an agent(s) action(s) create an externality it affects someone the agent has not engaged in a related market transaction. A negative externality is simply an externality that harms someone else.

   Negative externalities tend to create deadweight losses, particularly in competitive markets because competitive markets are usually unable allocate resources efficiently under such circumstances.

2. The supply curve pictured below is the sum of the marginal cost curves for each firm. This makes up the market supply curve. To find the marginal social cost curve we have to find the marginal external cost. The problem states that the external cost is \$50*Q's* units of a good. This means that the marginal external cost is 50. Now we can use the formula: *MSC* = *MEC* + *MC*. Applying the formula yields that the MSC curve is $Q/2 + 50 + 50 = MSC$



3. Since we know the MEC curve and the MC in the market (given by the supply curve), we can deduce from the formula *MSC* = *MEC* + *MC*, that $MSC = 75 + 3/2\,Q$. The shaded region represents the deadweight-loss.



4. Let us first find the competitive equilibrium. To do so, rewrite the marginal cost curve solving for P (solve for inverse demand of a single firm). Remember in competitive equilibrium we set *P* = *MC*. We get that $P/2 - 15 = Q$, which we now have to have to multiply by 10 (10 firms in the market) to the market supply curve, $5P - 150 = Q$. Now we can set supply equal to demand and find competitive equilibrium quantities.

$$Q^d = 1200 - 25P \overset{set}{=} 5P - 150 = Q^s$$
$$P = \$45$$

Plugging in the price into either the demand or supply function shows that, *Q = 75.*

Now we must solve for the efficient quantity. To come to an efficient quantity we know that the construction firms will be responsible for external costs of their production. Thus, *P* = *MSC* = *MC* + *MEC* $= 40 + 4Q^{firm}$. Solving for quantity in terms of price we get $Q = P/4 - 10$. Multiplying this previous result by 10, we get the market supply curve, $Q^S = 5/2\,P - 100$. Now equate demand and supply.

$$Q^S = 5/2\,P - 100 \overset{set}{=} 1200 - 25P = Q^d$$
$$P = \$47.27$$

Substituting the price into the demand function we get that the efficient quantity level is *Q* = 18.2 construction sites.

The deadweight loss created the firms is shown is similar to that shown on figure 20.1 in your textbook (p.756). Take the 75 construction sites under competitive equilibrium and substitute it in for Q in the *MEC* function, which yields 160. The height of the triangle is the difference between the 75 sites in competitive equilibrium and the 18.2 efficient quantity. The deadweight loss is found by computing the area of the triangle.

$$DWL = (75 - 18.2)(160)(0.5) = \$4{,}544$$

5. Let us first find the competitive equilibrium. To do so, rewrite the marginal cost curve solving for P (solve for inverse demand of a single firm). Remember in competitive equilibrium we set *P = MC*. We get that $P/2 - 15 = Q$, which we now have to have to multiply by 10 (10 firms in the market) to the market supply curve, $5P - 150 = Q$. Now we can set supply equal to demand and find competitive equilibrium quantities.

$$Q^d = 1200 - 25P \overset{set}{=} 5P - 150 = Q^s$$
$$P = \$45$$

Plugging in the price into either the demand or supply function shows that, *Q = 75.*

Now we must solve for the efficient quantity. To come to an efficient quantity we know that the construction firms will be responsible for external costs of their production. Thus, *P = MSC = MC + MEC* $= 50 + 4Q^{firm}$. Solving for quantity in terms of price we get $Q = P/4 - 12.5$. Multiplying this previous result by 10, we get the market supply curve, $Q^S = 5/2\,P - 125$. Now equate demand and supply.

$$Q^S = 5/2\,P - 125 \overset{set}{=} 1200 - 25P = Q^d$$
$$P = \$48.18$$

Substituting the price into the demand function we get that the efficient quantity level is *Q* =-4.5, so it is best not to produce any more construction sites *Q = 0.*

The deadweight loss created the firms is shown is similar to that shown on figure 20.1 in your textbook (p.756). Take the 75 construction sites under competitive equilibrium and substitute it in for Q in the *MEC* function, which yields 160. The height of the triangle is the difference between the 75 sites in competitive equilibrium and the 0 efficient quantity. The deadweight loss is found by computing the area of the triangle.

$$DWL = (75 - 0)(160)(0.5) = \$6{,}000$$

6. Let us first find the competitive equilibrium. To do so, rewrite the marginal benefit curve solving for P (solve for inverse demand of a single firm). Remember in competitive equilibrium we set *P = MC*. We get that $1200 - 25P = Q$. Now we can set supply equal to demand and find competitive equilibrium quantities. Notice that the marginal benefit is equal to the demand curve.

$$Q^d = 1200 - 25P \overset{set}{=} 5P - 150 = Q^s$$
$$P = \$45$$

Plugging in the price into either the demand or supply function shows that, $Q = 75$.

Now we must solve for the efficient quantity. To come to an efficient quantity we know that the construction firms will be responsible for external costs of their production. Thus, $P = MSB = MB + MEB = 53 - {}^{26Q}\!/_{25}$. Solving for quantity in terms of price we get $Q = 50.96 - {}^{25P}\!/_{26}$. Now equate demand and supply.

$$Q^S = 5P - 150 \overset{set}{=} 50.96 - {}^{25Q}\!/_{26} = Q^d$$
$$P = \$33.27$$

Substituting, the price into the demand function we get that the efficient quantity level is $Q = 16.36$.

The deadweight loss created the firms is shown is similar to that shown on figure 20.2 in your textbook (p.760). Take the 75 construction sites under competitive equilibrium and substitute it in for Q in the *MEB* function, which yields 70. The height of the triangle is the difference between the 75 sites in competitive equilibrium and the 16.36 efficient quantity. The deadweight loss is found by computing the area of the triangle.

$$DWL = (75 - 16.36)(70)(0.5) = \$2{,}052$$

7. An emission standard is a legal limit on the amount of pollution that a person or entity can produce from a particular activity. In order for the government to set an efficient emission standard it needs to know precisely the polluter's cost of abatement and the social costs. Thus, both sides have an incentive to overestimate the costs. On the one hand, the polluter will overestimate their cost of abatement so that the government places higher emission standards. The pollutee has the incentive to overestimate the social cost of emissions so that the government sets a lower emission standard.

8. A tax which taxes or imposes fees to correct for a negative externality is called a Pigouvian tax. In order to reach a socially efficient level the government would tax a firm until the marginal benefit of the externality equals the marginal cost of the externality. In effect, the Pigouvian tax creates an efficient market for the externality in question, where one did not exist before.

9. The efficient number of gnomes is found by equating the marginal benefit to the marginal cost.

$$MC = 2 + Q \overset{set}{=} 11 - {}^{1}\!/_{2}Q = MB$$
$$Q = 6 \textit{ gnomes}$$

At the efficient level of gnomes your marginal cost is \$8. Therefore, an efficient Pigouvian tax is \$8 per gnome. With such a tax your neighbor will choose to only 8 gnomes and will pay a total of \$48 dollars to have the gnomes running free in the garden.

10. Your neighbor's new estimate of her gnome benefit creates a new efficient level.

$$MC = 2 + Q \overset{set}{=} 17 - \tfrac{1}{2}Q$$

$$Q = 10 \ gnomes$$

As we can see from this example efficient level of gnomes has increased as your gnome-loving neighbor has increased her marginal benefit estimate. Clearly, there is an incentive to overstate her benefit from having gnomes in her garden. However, you and your other neighbors also have an incentive to overstate your marginal cost as well.

11. A liability rule is a legal principle that forces polluters that create an externality to compensate the affected parties for some or all of their losses. So a liability rule would make a polluter internalize the marginal cost of the externality they create. One of the difficulties that arise with implementing a liability rule are legal fees which are costly and time consuming.

12. A public good is a that is non-rival and non-excludable. In other words, everyone can have consume it and nobody can be denied its use. When it comes to contributing to pay for a public good agents have an incentive to contribute little or nothing to the public good because others are likely to contribute, and in that way the agent benefits from the contributions of others, this is what is known as the free rider problem.

13. First, we must compute the *MSB* of having plants in the classroom.

$$MSB = 7 \times (50 - 3Q) = 350 - 21Q$$

Now we set *MSB* = *MC*:

$$350 - 21Q = 14$$

$$Q = 16$$

Thus the socially efficient number of plants is 16. To find what each student would chose individually set *MB* =*MC*:

$$50 - 3Q = 14$$

$$Q = 12$$

Individually each student would choose to have 12 plants. If you notice, at Q = 16 the marginal cost exceeds the marginal benefit, such that each student will have an incentive to reduce the number of plants. The break-even point between marginal cost and marginal benefit is where Q = 12.

14. First, we must compute the *MSB* of having plants in the classroom.

$$MSB = 5 \times \left(\frac{30}{Q+1} \right) = \frac{150}{Q+1}$$

Now we set *MSB* = *MC*:

$$\frac{150}{Q+1} = 10$$
$$Q = 14$$

Thus the socially efficient number of plants is 14. To find what each student would chose individually set *MB* =*MC*:

$$\frac{30}{Q+1} = 10$$
$$Q = 2$$

Individually each student would choose to have 2 plants. If you notice, at Q = 14 the marginal cost exceeds the marginal benefit, such that each student will have an incentive to reduce the number of plants. The break-even point between marginal cost and marginal benefit is where Q = 2.

15. The median voter theorem is refers to voters with single-peaked preferences, in which a majority of them prefer the median ideal policy to all other policies. This theorem requires that the policy of the median voter coincide with the social benefit policy. In reality, they rarely coincide.