Chapter 2

Efficiency in Consumption

Throughout this chapter I shall assume that there are two goods, corn and wheat, and denote their prices P_C and P_W respectively. I shall also assume that there is one consumer, Alice, whose income is Y.

2.1 The Budget Constraint

I would like to know how much corn and wheat Alice will purchase. To answer this question, I begin by studying the limits of her purchasing power. Equation 2.1 is her budget constraint; it defines the combinations of corn and wheat that will use all of her income and no more.

$$Y = P_C C + P_W W \tag{2.1}$$

To graph Alice's budget constraint, I can rearrange equation it as shown below.

$$Y = P_C C + P_W W \Rightarrow P_C C = Y - P_W W \Rightarrow C = \frac{Y}{P_C} - \frac{P_W}{P_C} W \tag{2.2}$$

The last expression of equation 2.2 shows that the slope of the budget constraint is equal to the negative of the price of wheat over the price of corn and that the Y-axis intercept is Alice's income divided by the price of corn. Rearranging equation 2.2 to isolate W and setting C equal to zero will show that the X-axis intercept is Alice's income over the price of wheat. Figure 2.1 shows Alice's budget constraint.

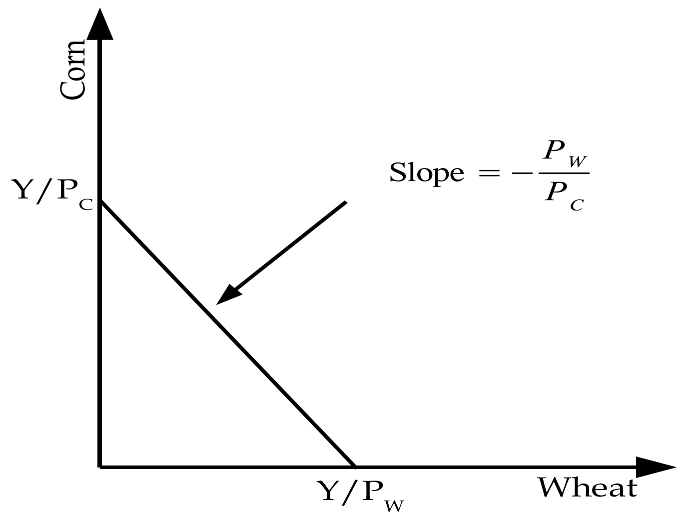

Figure 2.1: Alice's Budget Constraint

Alice can afford any of the consumption bundles on or within her budget constraint. For the moment I will not allow her to save, so any money that she does not spend is lost. It is reasonable to assume therefore that she will always pick one of the consumption bundles that make up her budget constraint.

Notice that when I graphed the budget constraint I took no account of how much corn and wheat were available for purchase. The budget constraint shows the consumption bundles that a consumer can afford given her income and the prevailing prices—it never takes into account the supply of goods.

Now let's consider the budget constraints that result when the price of one good is equal to zero. In particular, suppose that the price of corn is equal to zero: how can I graph Alice's budget constraint? I cannot use equation 2.2, as it now requires dividing by zero, but some simple reasoning will suffice. The X-intercept hasn't changed since the amount of wheat that Alice can purchase is still her income Y, divided by the price of wheat P_W. As for corn, she can have as much corn as she likes since it is free. Her budget constraint is therefore a vertical line that intersects the X-axis at Y/P_W, as depicted in the left-hand panel of figure 2.2.

If the price of wheat is equal to zero, the budget constraint is a horizontal

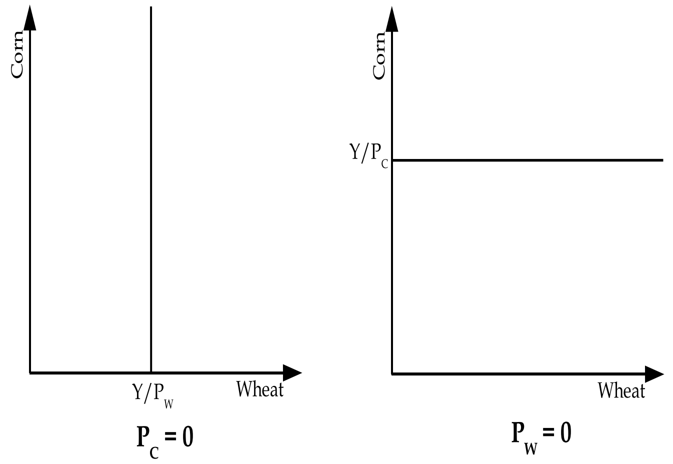

Figure 2.2: Two Extreme Budget Constraints

line passing through Y/P_C, as shown in the right-hand panel of figure 2.2. The budget constraints in figure 2.2 are the two budget constraint with the most extreme slopes. In more conventional instances, as the price of corn increases relative to the price of wheat, the budget constraint becomes flatter. When the opposite is true, the budget constraint becomes stepper.

2.2 Indifference Curves

Indifference curves represent a consumer's tastes or preferences. An indifference curve shows all the bundles of goods that give a consumer a particular amount of utility.[1] The consumer is indifferent between the bundles on the curve because they yield the same amount of satisfaction. Since indifference curves represent a consumer's tastes, two consumers will have different indifference curves unless they have identical tastes. Further, each consumer will have many, many indifference curves.

[1]So long as goods are desirable, the farther an indifference curve is from the origin, the higher the utility level it represents.

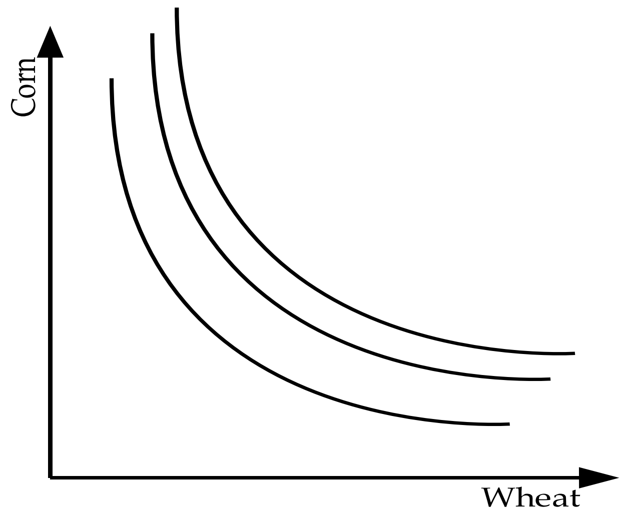

Figure 2.3: Indifference Curves

2.2.1 Three Restrictions

I shall impose three restrictions on the shape of indifference curves: they must be bowed inward, they must slope downward, and they must not cross. Figure 2.3 shows a set of indifference curves that obey these restrictions. To see why the restrictions that I imposed on indifference curves represent reasonable assumptions about consumer behavior, it is helpful to draw a series of indifference curves that violate the restrictions.

Figure 2.4 shows an indifference curve that slopes upward. Consider the points A and B. Point B provides more corn and more wheat than point A. Since our consumer likes both corn and wheat, she can't be indifferent between these two points—she must like point B better. Thus, her indifference curve cannot slope upwards.

The indifference curves in figure 2.5 slope downward, but they cross. According to the indifference curves, the consumer is indifferent between points A and B and points B and C. This means that she is also indifferent between points A and C. But point C gives her more corn and more wheat, so she must prefer C to A! This contradiction illustrates why her indifference curves cannot cross.

Figure 2.6 shows an indifference curve that is bowed outward. Its slope

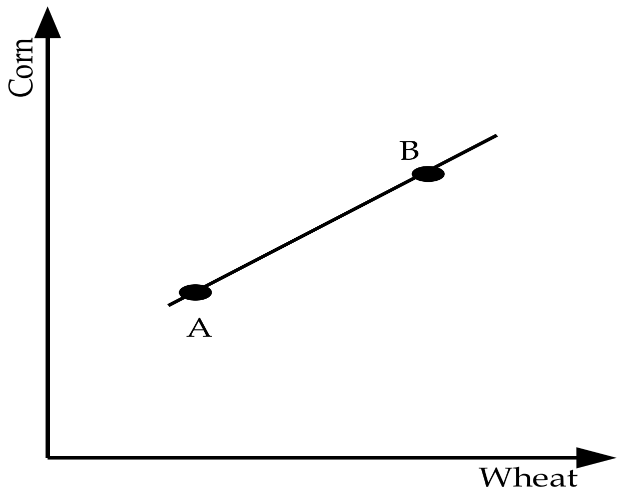

Figure 2.4: An Upward Sloping Indifference Curve

is the change in corn over the change in wheat: $\Delta C/\Delta W$. The slope of the indifference curve tell us the amount of corn that the consumer can exchange for one unit of wheat and leave her utility unchanged. The indifference curve has different slopes at different points, meaning that the amount of corn and wheat that our consumer has affects her willingness to exchange corn for wheat.

In particular, the shape of the indifference curve in figure 2.6 means that when a consumer has a lot of corn and little wheat (i.e., point A), she requires a relatively large amount of wheat to compensate her for losing a bit of corn (i.e., moving to point B). The opposite is true further along her indifference curve: when she has less corn and more wheat (i.e., point C), she requires very little wheat to compensate her for the loss of a large amount of corn (i.e., moving to point D). In other words, the more corn our consumer has, the more she values it relative to wheat.

Inward bowed indifference curves make the opposite assumption: the less corn a consumer has, the more she values it relative to wheat. While either assumption could be correct, indifference curves that are bowed inward make more sense: a consumer values a good more highly when her stock of it is low than when her stock of it is high.

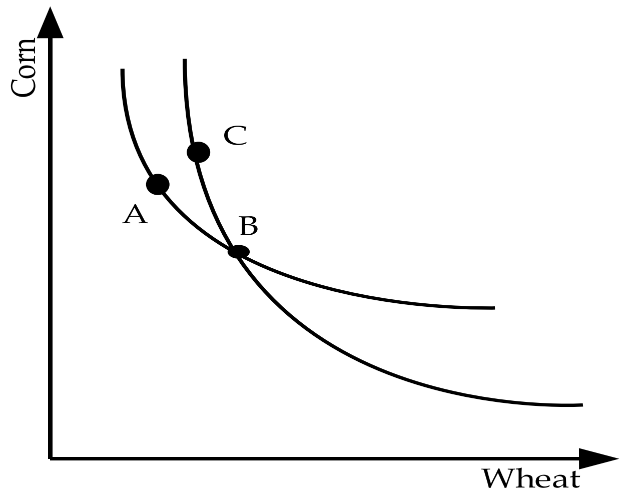

Figure 2.5: Crossing Indifference Curves

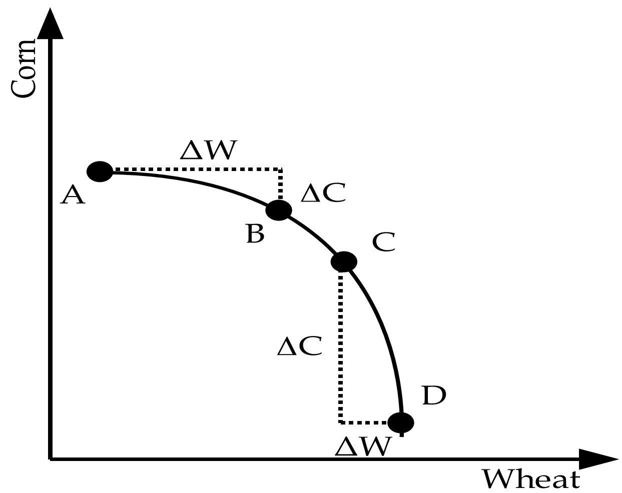

Figure 2.6: A Bowed Out Indifference Curve

2.2.2 Complements and Substitutes

While indifference curves cannot be bowed outward, they can be straight lines. If two goods perform exactly the same purpose, a consumer will be willing to exchange them at a fixed ratio. Such goods are known as perfect substitutes. For example, most consumers would consider two different brands of paper towels to be equivalent and would be willing to trade a roll of brand A for a roll of brand B. Indifference curves for perfect substitutes are straight lines. Figure 2.7 illustrates perfect substitutes and a related concept, perfect complements.

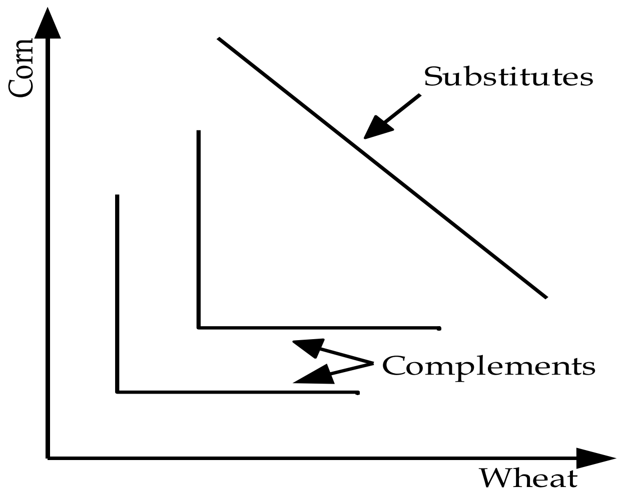

Figure 2.7: Complements and Substitutes

Goods that are perfect complements are the exact opposite of perfect substitutes. Complementary goods must be consumed in tandem to generate utility. The classic example is left and right shoes. If you have one right shoe and one left shoe, adding another right shoe doesn't increase your utility; to increase your utility, you must add both a left shoe and a right shoe. Complements generate L-shaped indifference curves.

Many goods are neither perfect complements nor perfect substitutes. The indifference curves representing consumers' preferences with respect to these goods have shapes between the shapes shown in figure 2.7.

2.3 The Demand Curve

A demand curve shows the relationship between a consumer's demand for a good and the price of that good. I can use Alice's budget constraint and indifference curves to determine her demand curve. Her budget constraint defines the bundles of goods that she can afford and her indifference curves specify which of these bundles is her most preferred bundle. Figure 2.8 shows Alice's budget constraint and a few of her indifference curves.

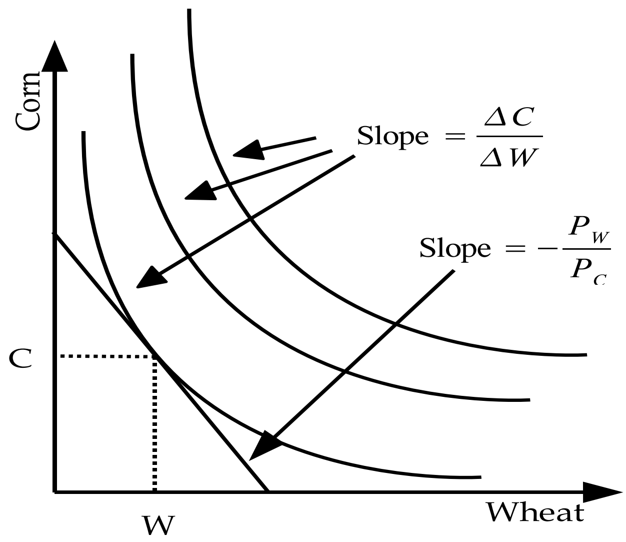

Figure 2.8: A Consumer's Optimal Consumption Bundle

Figure 2.8 also shows the amount of corn and wheat that Alice will demand given prices P_C and P_W and income Y. She wants to reach the highest indifference curve possible, which in this case—and most cases—is the point of tangency between her indifference curve and the budget constraint. At this point she demands C units of corn and W units of wheat. Since this is a tangency, the slopes of the indifference curve and the budget constraint are equal:

$$\frac{\Delta C}{\Delta W} = -\frac{P_W}{P_C} \tag{2.3}$$

Suppose that I am creating Alice's demand curve for wheat. Figure 2.8 tells me the quantity of wheat she will demand at price P_W given that the

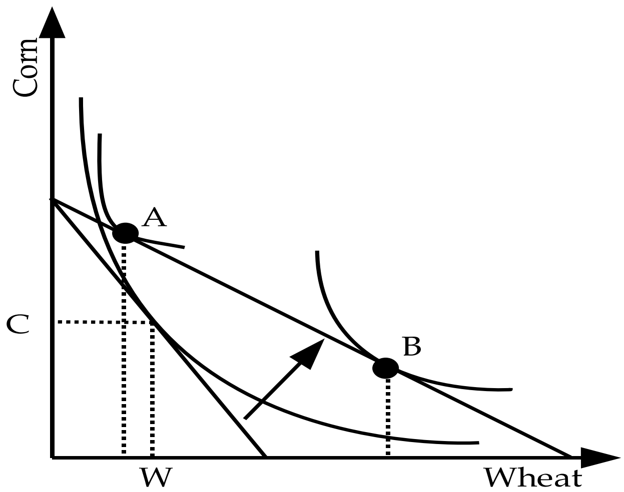

Figure 2.9: A Decline in PW

price of corn is fixed at P_C. To get another point on the demand curve, I vary the price of wheat while keeping the price of corn and Alice's income fixed.

Suppose, for example, that the price of wheat decreases. How much wheat will Alice demand at this new price? You might expect the answer to be more, but in fact one cannot be sure that this is true. Figure 2.9 illustrates the new situation. The budget constraint has the same Y-axis intercept since the price of corn and Alice's income haven't changed. Because the price of wheat has dropped, the X-axis intercept has shifted to the right and the budget constraint's slope is flatter.

The two new indifference curves in figure 2.9 represent different tastes.[2] I don't know Alice's tastes, so either of these indifference curves is possible. If the indifferent curve tangent to point A represents Alice's tastes, her demand for wheat will decrease. If the indifference curve tangent to point B represents Alice's tastes, her demand for wheat will increase. Without knowing Alice's tastes exactly, I cannot tell which indifference curve (if either) correctly represents her tastes. Thus, I cannot be sure whether her demand for

[2]Notice that both of these indifference curves respect my three restrictions on indifference curves.

wheat will increase or decrease. Figure 2.9 therefore shows that my three restrictions on indifference curves are not enough to predict how a consumer's demand for a good will change in response to a change in that goods price.

The uncertainty about the relationship between price and demand arises because a fall in the price of a wheat has two effects. First, it makes wheat relatively cheaper compared to corn, which increases demand for wheat. This effect is known as *the substitution effect*. Second, it makes the consumer wealthier because she can know buy more with her income (i.e., it rotates the budget constraint outward). This effect, which is known as *the income effect* is ambiguous: it may increase of decrease the consumer's demand for wheat. If the income effect increases our consumer's demand for wheat (i.e., the consumer demands more wheat as she becomes wealthier), then demand for wheat will rise when the price of wheat falls. If the income effect decreases our consumer's demand for wheat and it is larger than the substitution effect, then a fall in the price of wheat will decrease demand for wheat.

If the demand for a good decreases when its price decreases, it is called a Giffin good[3]The economist who first argued that such goods might exist was named Giffin. For the moment, I shall assume that wheat is not a Giffin good. If this is true, then by definition a decrease in the price of wheat will increase the demand for wheat and a rise in the price will decrease demand. Figure 2.10 shows a hypothetical demand curve for wheat. Remember that this demand curve is for a fixed price of corn, a fixed income, and fixed preferences—our consumer's tastes don't change when the price of wheat changes.

As I have said, the demand curve for one good holds the prices of other goods fixed. In some cases though we are interested in the effect of a change in the price of one good on the demand for another good. For example, we might be interested in how a rise in the price of corn will affect the demand for wheat. If two goods are substitutes, a rise in the price of one of the goods leads to an increase in the demand for the other (as consumers substitute the good whose prices hasn't changed for the good whose price has risen). If two goods are complements, the opposite happens: a rise in the price of one good decreases demand for the other good (e.g., if the price of left shoes rises, demand for right shoes declines because one has to buy a left shoe to get utility from a right shoe).

Since a demand curve is for a particular income, changing the consumer's

[3].

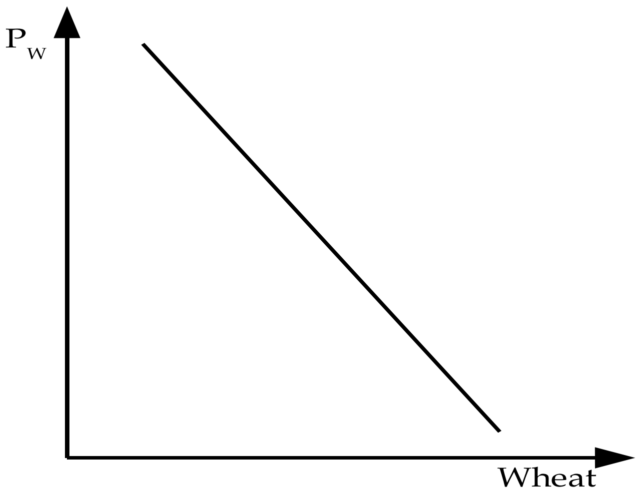

Figure 2.10: The Demand for Wheat

income shifts the entire demand curve. If the demand for a good rises (i.e., the demand curve shifts to the right) when income rises, the good is called a *normal good*. If the demand for a good falls when income rises (i.e., the demand curve shifts to the left), it is called an *inferior good*.

Normal goods can never be Giffin goods. To see why, suppose that corn is a normal good and that its price falls. The substitution effect increases demand for corn because corn is now relatively cheaper than wheat. The income effect also increases demand for corn because the fall in the price of corn makes the consumer wealthier and corn is a normal good. Since the income and substitution effects work in the same direction, the demand for corn must increase. Note carefully that while all Giffen goods are inferior goods, not all inferior goods are Giffen goods (since the income effect may be dominated by the substitution effect).

2.4 Efficiency

I shall now consider a new consumer, Finn, in addition to Alice. Alice and Finn face the same prices—P_C and P_W—but they have different incomes: Y_A And Y_F, respectively. I want to determine whether they will consume efficiently if left to their own devices. To do so, I need the following definition of efficiency.

Definition 1 *An allocation of goods is* Pareto efficient *if it is impossible to make one person better off without making someone else worse off.*

In my two consumer example, an allocation is Pareto Efficient if the consumers cannot work out a trade that helps one of them without hurting the other. The critical result of this section is that if our two consumers face the same prices, their consumption bundles will be efficient.

Returning to my example, the left-hand pane of figure 2.11 shows Alice's budget constraint, one of her indifference curves, and her consumption bundle. The right-hand pane shows Finn's budget constraint, one of his indifference curves, and his consumption bundle.

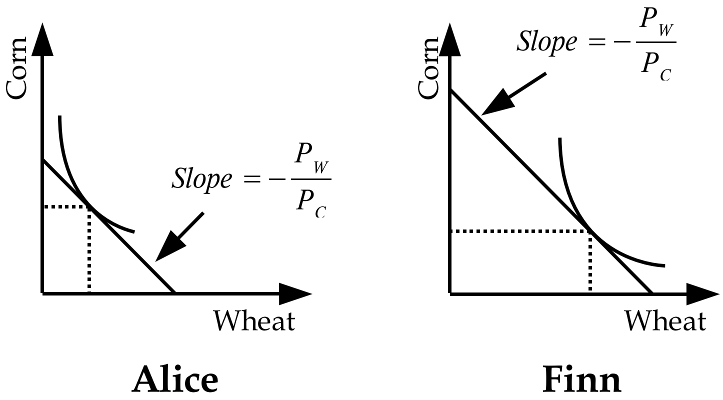

Figure 2.11: An Efficient Allocation

Since Alice's indifference curve is tangent to her budget constraint, the slopes of these objects must be equal. The same is true for Finn. That is, for both consumers

$$\frac{\Delta C}{\Delta W} = -\frac{P_W}{P_C} \tag{2.4}$$

But since Alice and Finn face the same prices, this must mean that

$$\frac{\Delta C}{\Delta W}_A = \frac{\Delta C}{\Delta W}_F \tag{2.5}$$

Our consumers are willing to exchange corn for wheat at exactly the same rate. Thus, they cannot find a trade that makes one of them better off without harming the other. This means that the allocation of goods is efficient. Figure 2.12, by way of contrast, shows an allocation that is not efficient.

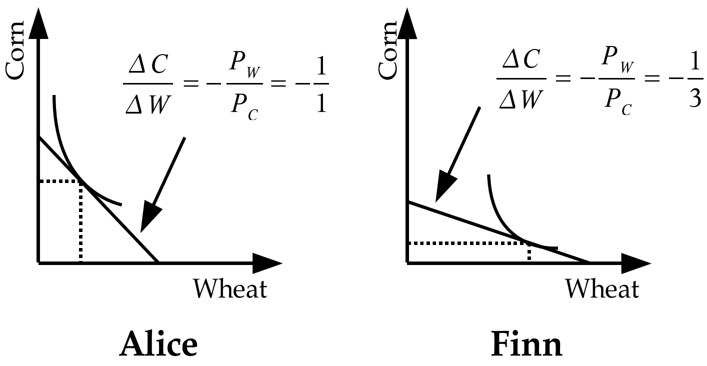

Figure 2.12: An Inefficient Allocation

What has gone wrong? Alice and Finn face different prices. The price of wheat is \$1 for both consumers, but the price of corn is \$1 for Alice and \$3 for Finn. As a result, their indifference curves have different slopes at their points of tangency. Thus,

$$\frac{\Delta C}{\Delta W}_A \neq \frac{\Delta C}{\Delta W}_F \tag{2.6}$$

Since our consumers want to trade corn and wheat at different ratios, they can find a mutually advantageous trade. In particular, Alice could give Finn half a unit of corn in exchange of one unit of wheat. This trade makes Alice better off because she requires only half a unit of wheat to compensate her for losing half a unit of corn. The trade makes Finn better off since he requires only one-third of a unit of corn to compensate him for losing one unit of wheat.

When consumers face the same prices, the allocation of goods that they reach by their independent actions is efficient. When they face different prices, the resulting allocation will generally be inefficient. The critical issue is therefore whether consumers face the same prices.

One force that tends to equalize prices is arbitrage. If prices are different in two locations, entrepreneurs can buy the goods in the cheaper location and sell them in the expensive location, earning profit as they do so. This will force prices to equalize. The effect of arbitrage is reduced by transportation costs. If the difference in price between two locations is smaller than the cost of transporting the goods between the locations, arbitrage will not be profitable and will not be undertaken. Thus, low transportation costs tend to lead to equal prices.

Comparison shopping, another force that equalizes prices, is the action of checking a good's price at several locations before purchasing it. Comparison shopping forces locations to charge the same price. The effect of comparison shopping can be reduced by search costs; if checking prices is costly, locations may be able to sustain price differences. The increase in on-line shopping should increase consumer's ability to comparison shop, but comparison shopping is also limited by branding, which seeks to create perceived quality differences between identical products.

2.5 Problems

1. Mark has \$200 that he can spend on books or movie tickets. A book costs \$10 and a movie ticket costs \$5.

    (a) Draw Mark's budget constraint, labeling the slope and the intercepts.

    (b) Draw one of Mark's indifference curves for movie tickets and books. Show the amount of books and movie tickets that he will choose to buy.

    (c) Suppose that Mark's income increase to \$400. On the same graph you used in part B, draw the new budget constraint and indicate the slope and the intercepts.

(d) Show graphically the amount of books and movie tickets Mark will buy after his income increases.

(e) Based on your answer to part D, what happens to Mark's demand for movie tickets when his income rises?

2. (a) What does an indifference curve measure?

   (b) Assume Janet is able to consume two goods: CDs and brownies. She earns \$300 a week. The price of CDs is \$10 and the price of brownies is \$3. Draw a set of indifference curves for her.

   (c) Draw her budget line. Label the intercepts and slope. Indicate at which point she will consume.

3. Siobhan earns an income of \$Y and can purchase only two goods: tickets to curling matches (denoted C) or tickets to Gaelic football matches (denoted G). The prices of the tickets to the curling and Gaelic football matches are P_C and P_G respectively.

   (a) Write down the equation for Siobhan's budget constraint. (5 points)

   (b) Let $Y = \$12$, $P_C = \$2$ and $P_G = \$3$. Graph Siobhans budget constraint, labeling its slope and intercepts.

   (c) Suppose that Siobhan considers curling and Gaelic football to be perfect substitutes. Using this information and your graph in part 3b, show how many curling tickets and how many Gaelic football tickets she will purchase.

   (d) Now suppose that there is another consumer named Finn who earns \$12 and considers curling and Gaelic football to be substitutes. For Finn, $P_C = \$2$ but $P_G = \$2$ (he receives a discount because his brother plays for the Gaelic football team). Using this information and your answer to part 3c, draw Finn's budget constraint and indifference curves and explain whether Finn and Siobhan can make a mutually beneficial trade.

4. Ben brings \$30 with him to a baseball game to spend on cookies and hot dogs.

   (a) Draw Ben's budget constraint, labeling the intercepts and slope, if the prices of cookies and hot dogs are \$1 and \$5, respectively.

(b) Ben is a normal guy so his indifference curves can't slope upward or be bowed outward. Explain why not.

(c) Ben goes to the game and eats 6 hot dogs and no cookies. Depict his choice in your diagram from part A, making sure that your indifference curves satisfy our three assumptions about indifference curves.

(d) Now suppose that a cookie costs \$2 and a hot dog \$5. What will Ben's new consumption bundle be? Use this information to draw Bens demand curve for cookies, explaining why you have chosen the shape you depict.

2.6 Solutions

1. (a) We can solve this part using the budget constraint

$$Y = P_B B + P_M M \tag{2.7}$$

Let M = 0 and we have $200 = 10B$ so $B = 20$. Let $B = 0$ and we have $200 = 5M$ so $M = 40$. Finally, if we put B on the Y-axis and M on the X-axis, the slope is $-P_M/P_B = -1/2$. So the intercepts are $B = 20$ and $M = 40$ and the slope is $-1/2$.

(b) Mark will consume at the point of tangency between one of his indifference curves and his budget constraint. His indifference curves should slope downward, be bowed inward, and not intersect.

(c) The slope doesn't change because it depends only on the price ratio, which has not changed. Replacing 200 by 400 in the calculations in part 1a yields intercepts of $B = 40$ and $M = 80$.

(d) Again, Mark will consume at the point of tangency between one of his indifference curves and his budget constraint. The diagram in part 1b constrains the choice of the new consumption point. In particular, the new consumption point must be located between the two points at which the indifference curve in 1b intersects the new budget line.

(e) It is possible for consumption of movie tickets to increase or decrease based upon the rendition of Mark's indifference curves in parts 1b and 1d.

2. (a) Either of the following is acceptable.

   i. Indifference curves measure utility. Each curve represents bundles of goods that yield the same utility for a given consumer.

   ii. Indifference curves show all the bundles of goods between which a given consumer is indifferent.

   (b) Your indifference curves should be downward sloping and bowed inward. They should not cross.

   (c) The relevant equation is the budget constraint:

$$Y = P_{CD}CD + P_BB \tag{2.8}$$

Let $CD = 0$ and we have $300 = 3B$ so $B = 100$. Let $B = 0$ and we have $300 = 10CD$ so $CD = 30$. Thus our intercepts are 30 CD and 100 B. Put CD on the Y-axis and B on the X-axis. Then we can write

$$P_{CD}CD = Y - P_BB \Rightarrow CD = \frac{Y}{P_{CD}} - \frac{P_B}{P_{CD}}B \tag{2.9}$$

and the slope of our budget constraint is

$$-\frac{P_B}{P_{CD}} = -\frac{3}{10} \tag{2.10}$$

Janet will consume at the point where an indifference curve is tangent to her budget constraint or at one of the intercepts.

3. (a)

$$Y = P_CC + P_GG \tag{2.11}$$

   (b) It is easy to plot the budget constraint by converting the above equation to slope-intercept form.

$$C = \frac{Y}{P_C} - \frac{P_G}{P_C}G \Rightarrow C = 6 - \frac{3}{2}G \tag{2.12}$$

The Y-axis intercept is 6, the X-axis intercept is 4, the slope is -3/2, as shown in figure 2.13.

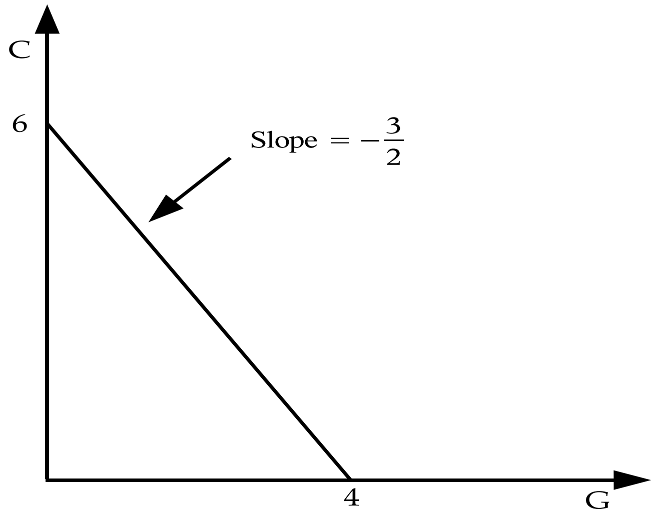

Figure 2.13: Siobhan's Budget Constraint

(c) Since Siobhan views C and H as perfect substitutes, her indifference curves have a constant slope. If the slope of Siobhan's indifference curves is less than -3/2, she will consume 4 G and 0 C. If the slope of her indifference curves is greater than -3/2, she will consume 0 G and 6 C. If the slope of her indifference curves is -3/2, she can consumer any bundle on her budget constraint. I assume a slope of -2 in the figure 2.14.

(d) The answer to this question depends on what you did in part C and how you drew Finn's indifference curves. I shall assume that Finn's indifference curves have a slope of -1/2 (since he views C and G as perfect substitutes, his indifference curves have a constant slope). Figure 2.15 shows Finns budget constraint and one of his indifference curves. In my example, despite facing different prices, Finn and Siobhan cannot make a mutually beneficial trade. Siobhan has only G and she values G twice as much as C. Finn has only C and he values C twice as much as G. The only case in which Siobhan and Finn can trade is when both of their indifference curves are tangent to their budget constraints and they both choose interior consumption bundles.

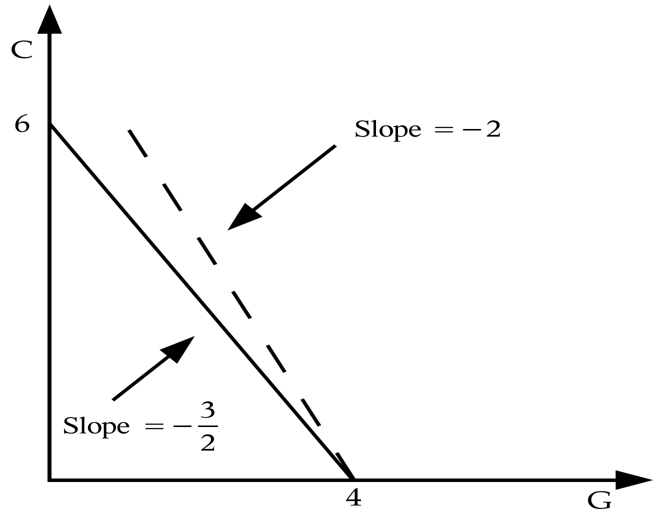

Figure 2.14: One of Siobhan's Indifference Curves

4. (a) The equation for Ben's budget constraint is

$$H = \frac{Y}{P_H} - \frac{P_C}{P_H}C \Rightarrow H = 6 - \frac{1}{5}C \tag{2.13}$$

The Y-axis intercept is 6, the X-axis intercept is 30, and the slope is -1/5. Figure 2.16 illustrates parts 4 and 4b.

(b) An upward sloping indifference curve implies that the consumer is indifferent between two bundles, one of which contains more of both goods. An indifference curve that is bowed outward implies that the consumer values a good more when she has a lot of it than when she has a little of it. Both of these implications violate our assumptions about consumer preferences.

(c) The point Z is Ben's consumption point.

(d) If the price of cookies rises, Ben's budget constraint shifts inward. As the right-hand pane of the figure 2.17 shows, there is no need to worry about Giffen goods; Ben wont increase his consumption of cookies because his original bundle (which contained no cookies) is still affordable, and all other points on the new budget constraint must give him lower utility. The price of cookies has gone up and

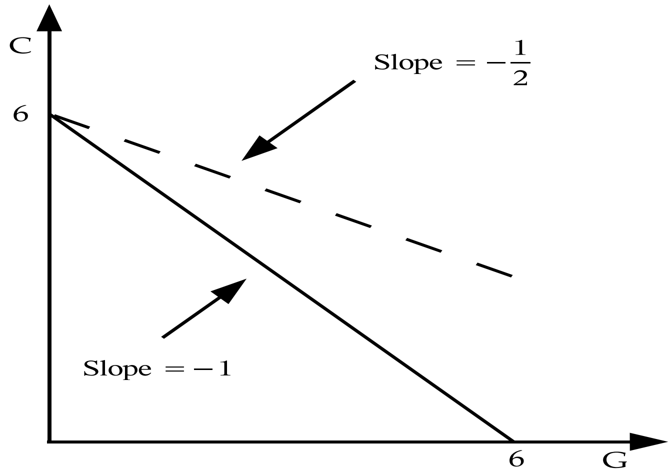

Figure 2.15: One of Finn's Indifference Curves

Ben still demands no cookies. In fact, for every PC above \$1, Ben will purchase no cookies. As the left-hand pane of figure 2.17 shows, at some price below \$1 he begins to purchase cookies.

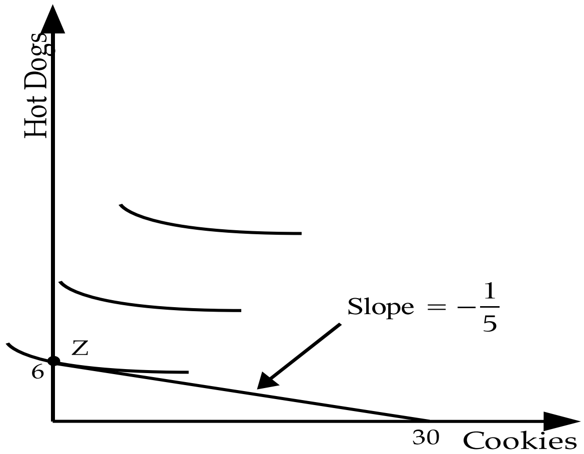

Figure 2.16: Ben's BC and Indifference Curves

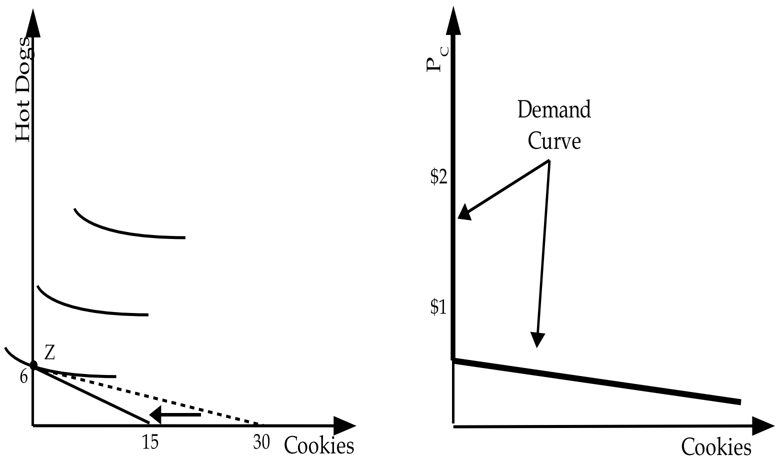

Figure 2.17: Ben's New Budget Constraint and His Demand Curve