

Chapter 3: Consumer Behavior

In this chapter, we begin our “behind the scenes” look at the demand curve. Specifically, we attempt to explain why consumers behave the way they do. By understanding the way an individual consumer chooses what products to buy, we can generalize our understanding to the way consumers as a group behave in markets.

As P&R note, there are three basic components to the economic theory of consumer choice, and we will examine each in this chapter:

- 1) Consumer Preferences. Why do consumers prefer one group of goods to another? How can we study these preferences in a meaningful way?
- 2) Budget Constraints. Consumers cannot buy whatever they like. They are constrained by their income or budgets. How can this constraint be factored into our model?
- 3) Consumer Choice. Given their preferences and budgets, how do consumers decide what to buy?

As you will see, the economic treatment of these issues is rather abstract, and may seem wildly unrealistic. Remember that this is a model. Economists do not really believe that consumers, literally, solve a multivariate constrained maximization problem every time they go to WalMart. Rather, we argue that they behave *as if* they solved such a problem. Even if the actual intuitive decisions made by real-life consumers are made differently than we describe, the point is that our model does seem to produce accurate predictions about consumer behavior, even if it seems more than a little unrealistic.

Consumer Preferences

In order to describe consumer preferences, we must first describe what, exactly, consumers are supposedly expressing preferences among. We model consumers as expressing preferences among “baskets” (or “bundles”) of goods.

A market basket (or market bundle) is a list showing specific quantities of one or more specific goods. It might help to literally visualize a basket containing a certain amount of certain goods, and thinking of the consumer preferring the contents of one basket to the contents of another.

For example (text), suppose that our hypothetical consumer is interested in food (F) and clothing (C). She might be asked to consider the following baskets:

<u>Basket</u>	<u>Units of Food</u>	<u>Units of Clothing</u>
A	20	30
B	10	50
D	40	20
E	30	40
G	10	20
H	10	40

(Notice that we omit baskets C and F to avoid confusion with Clothing and Food subscripts. Also notice that we don't care what units we're using to measure quantities of food and clothing because such measures are fairly arbitrary and will vary from consumer to consumer and product to product).

How can we tell the consumer will prefer one basket to another? Or be indifferent (equally satisfied) with two particular baskets?

To answer this question, we assume that consumer "satisfaction" or "happiness" can be expressed in terms of utility. A consumer's utility is a numerical measure of the satisfaction a consumer gets from a particular market basket. We further posit the existence of a utility function that shows the level of utility generated from various combinations of goods. Using food and clothing as our two goods, a utility function would be written as

$$U = U(F, C)$$

If I give the consumer a particular amount of food and a particular amount of clothing, the consumer will derive a particular level of utility as dictated by her utility function.

One thing that is important to note about utility immediately: it is an ordinal, not a cardinal measure. By "ordinal" we mean that higher levels of utility translate into higher levels of satisfaction, but that differences in utility do not translate into absolute differences in satisfaction. For example, suppose that bundle X gives a consumer $U = 10$ while bundle Y gives her $U = 20$. This would allow us to say that the consumer prefers Y to X. However, it is *not* correct to say that Y makes the consumer twice as happy as X. Such a statement obviously makes no sense (can you think of a bundle that makes you exactly twice as happy as another?) and is unnecessary in any case.

Also, utility is personal. It is completely illegitimate to say that a bundle gives Tom $U = 50$ and Sarah $U = 100$ so it makes Sarah happier than Tom. Again, such a comparison is absurd. The utility function is only a way of *ranking* market baskets for a *particular* consumer.

When stating that a basket is preferred to another, we will use the $>$ operator. If two baskets produce the same level of utility so that the consumer is indifferent between them, we will use the \sim operator. Thus the following:

$A > B$	“A is preferred to B”
$B > A$	“B is preferred to A”
$A \sim B$	“The consumer is indifferent between A and B”

To develop our model of consumer behavior, we will make a series of assumptions about utility functions and the way consumers rank bundles. These assumptions are sometimes called axioms. They cannot be proved to hold in practice, but as you will see they are fairly obvious and uncontroversial.

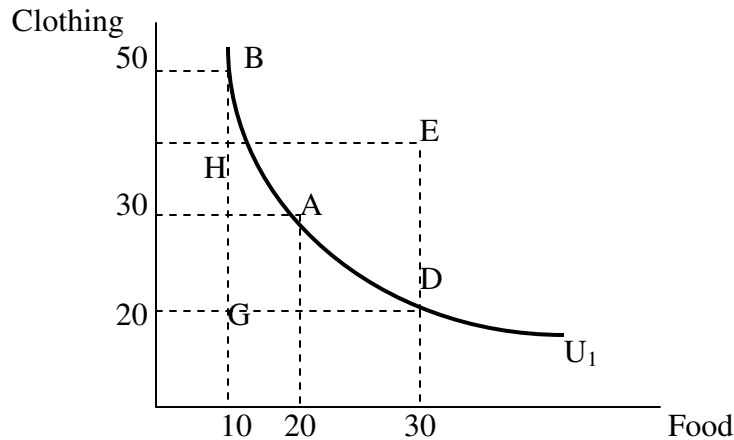
A1) Completeness. Consumers are able to rank all possible baskets, so that preferences are complete. In other words, for any two market baskets X and Y, the consumer will either prefer X to Y, Y to X, or be indifferent between the two. “Does not compute” is not a possibility. In our notation, either $X > Y$, $Y > X$, or $X \sim Y$.

A2) Transitivity. If a consumer prefers basket X to basket Y, and he prefers Y to Z, then he also prefers X to Z. In other words, if $X > Y$ and $Y > Z$, then $X > Z$.

A3) Nonsatiation. Consumers always prefer more to less (they are never satisfied or satiated and always want more). Thus, if basket X contains more food *and* more clothing than basket Y, then $X > Y$. Another way to say this is that $\partial U/\partial F > 0$ and $\partial U/\partial C > 0$ (all partial derivatives of the utility function must be positive).

With these axioms in mind, we can represent a consumer's preferences graphically. Suppose a consumer has a utility function $U(F,C)$ and I want to know what combinations of food and clothing are perceived as equivalent by this consumer. In other words, if I take food out of a basket, how much clothing do I have to add to keep the consumer as happy (same U) as before?

The answer to this question gives us an indifference curve, which shows all market baskets that provide the consumer with the same level of utility. The following graph shows a possible indifference curve:



We have put clothing on one axis and food on the other axis, so that each point on the graph represents a possible market basket. Here we have graphed each of the baskets described earlier. The indifference curve U_1 shows all market baskets that give consumer $U = U_1$. All the baskets on the indifference curve are equivalent as far as this consumer is concerned.

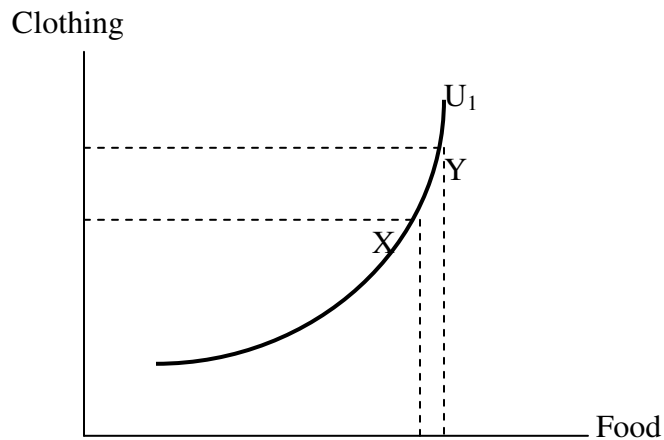
On this diagram, we have drawn U_1 so that A, B and D all lie on the same indifference curve. Thus, $A \sim B \sim D$.

This curve allows us to say more, though. Note that E has more food and more clothing than A. Thus, the nonsatiation axiom tells us that $E > A$, and transitivity guarantees that $E > B$ and $E > D$ as well.

H has the same amount of food as B, but less clothing. Thus, B is strictly better than H, so $B > H$, $A > H$, and $D > H$. Notice that we know that $D > H$ even though D does not have more of both goods than H. We are able to tell this preference by transitivity. The same goes for G with $E > A, B, D > G$. We also know that $H > G$ by nonsatiation. Thus, this one indifference curve allows us to tell that this consumer would rank these bundles in the following order of preference: E, (A, B, D), H, G. Without the indifference curve, we could have assumed some of these relationships ($E > G$, for instance), but not all of them.

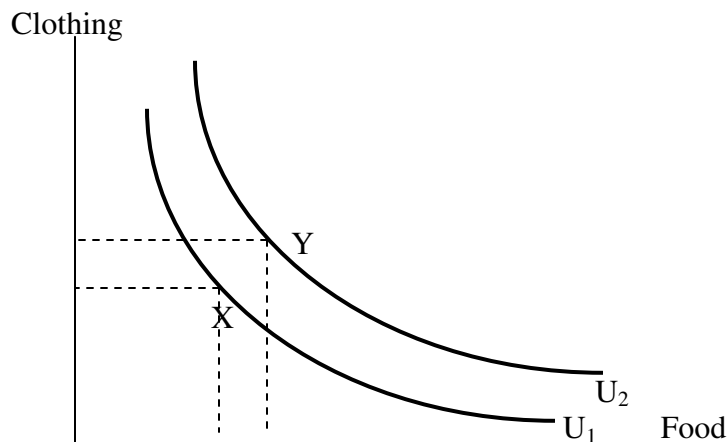
What do our axioms tell us about the shape of indifference curves?

1) They must slope down. Basically, this says that if you give the consumer more food, you must take away clothing to keep his utility the same. Suppose that the indifference curve instead was upward-sloping. This would mean that the consumer would be indifferent between a bundle and another bundle with more of both goods, which violates our nonsatiation axiom. This situation is illustrated below:



According to this indifference curve, $Y \sim X$. But this violates nonsatiation which says that Y must be preferred to X . Thus, it is impossible for indifference curves to slope up.

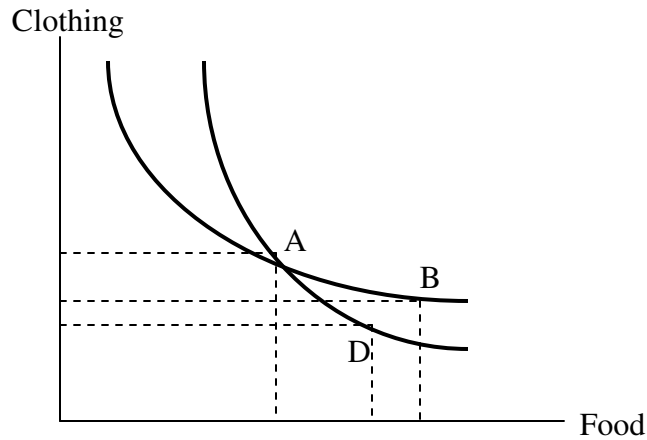
2) There are an infinite number of them. We drew one indifference relation, showing the various bundles that produced $U = U_1$. Obviously, other bundles will produce different utility levels.



U_1 shows bundles that all produce $U = U_1$. U_2 shows all bundles that produce $U = U_2$. We could also draw similar curves for other utility levels.

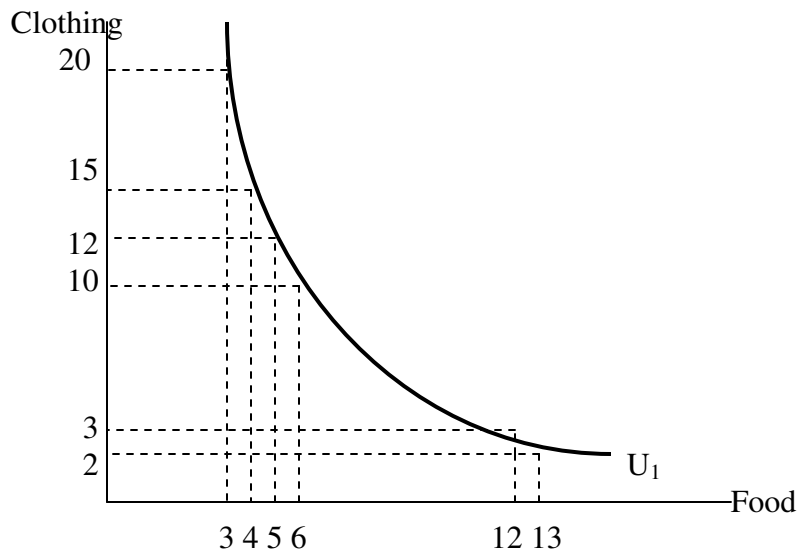
3) As we move to the northeast, utility levels rise. Note that on the above diagram, Y has more of both goods than X . Thus, $Y > X$. But that means that $U_2 > U_1$. In other words, indifference curves lying further up and to the right carry higher levels of utility.

4) Indifference curves cannot intersect. To see why this is the case, suppose for a moment that two curves *did* intersect as shown below.



These curves intersect at basket A. Because A lies on the same indifference curve as B, $A \sim B$. Because A also lies on the same curve as D, $A \sim D$. Transitivity tells us that since $B \sim A \sim D$, then $B \sim D$. But this violates nonsatiation. Therefore, it is impossible for indifference curves to intersect.

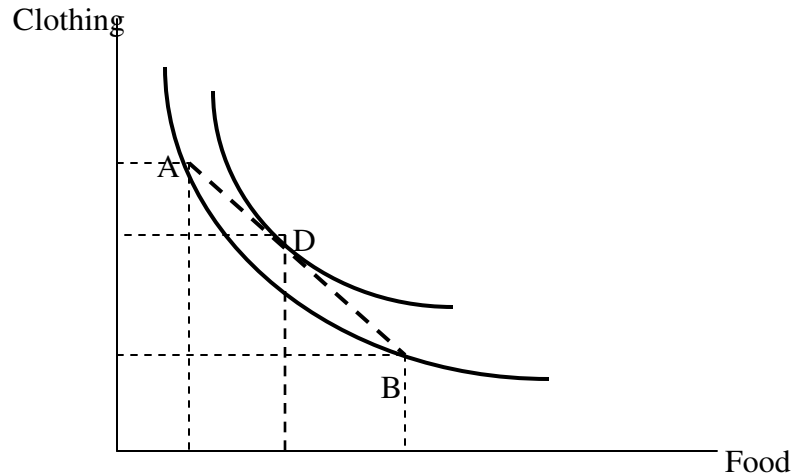
Usually, we also draw indifference curves as convex. That is, they get flatter as you increase the X-axis variable. A moment's reflection shows that while this need not be true for all goods, it makes sense for most goods. Consider the following curve:



Suppose the consumer starts with 20 units of clothing and 3 units of food $(F,C) = (3,20)$. Then we take away clothing and add food to keep the consumer just as well off. At first, the consumer has so much clothing and so little food that he is quite willing to part with clothing to get more food. At first, the consumer is willing to give up 5 units of clothing to get one more unit of food. As we go along, however, this changes. As the consumer gets more and more food and less and less clothing, he is less willing to give up clothing for food.

To get another unit of food, the consumer is willing to give up only 3 units of clothing, 2 for the next unit of food, and so on.

Another way to think about this is to note that consumers always prefer an “average” bundle to a bundle heavily weighted toward either good. They prefer “some of both” to “one or the other” in other words. Geometrically, this means that a bundle lying on a line segment between two equivalent bundles will be preferred to those bundles.



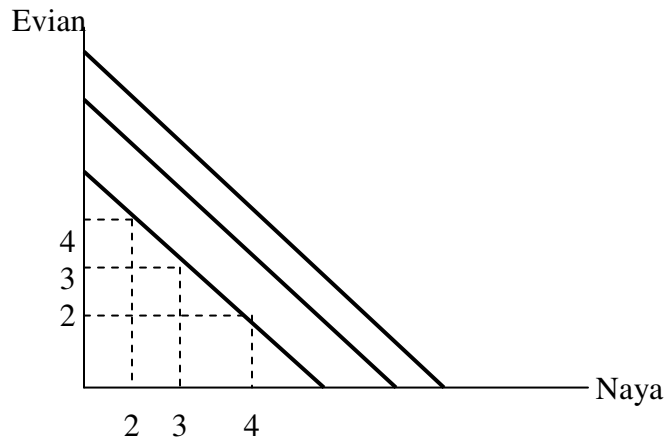
A ~ B, and D lies on a segment connecting A and B. But D lies on a higher indifference curve than A and B, so $D > A$ and $D > B$ because it is more balanced. This is just another implication of indifference curves being convex.

We define the marginal rate of substitution (MRS) as the amount of a good that a consumer is willing to give up to obtain an additional unit of another good. We will always define the MRS as the amount given up of the Y-axis variable to get more of the X-axis variable (as P&R do). Thus, this consumer’s MRS is 5 when $F=3$, 3 when $F=4$, and 1 when $F=12$.

Notice also that mathematically, $MRS = -\Delta C/\Delta F$ (minus sign added to make this positive). But this is simply the slope of the indifference curve at a point! Using calculus, we could write the MRS as dC/dF and interpret it exactly the same way.

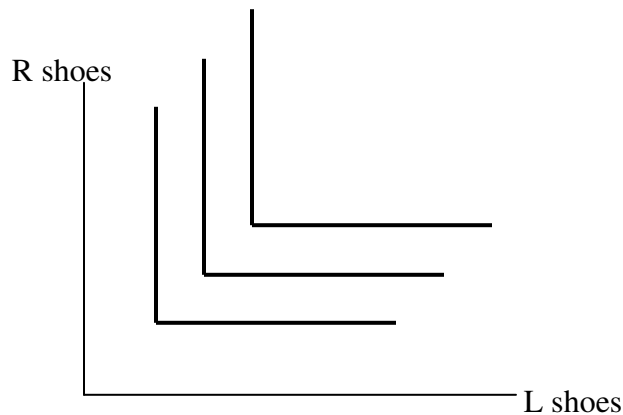
So the MRS is the slope of the indifference curve and the slope of indifference curves usually decreases due to convexity. Thus, the marginal rate of substitution is normally falling as we move along an indifference curve. This result is called the a diminishing marginal rate of substitution and is often added as an assumption about indifference curves in general (a fourth axiom).

We should note here, though, that while it is very hard to imagine a consumer whose preferences violate transitivity, nonsatiation, or completeness, it is easy to imagine preferences over some goods that do not exhibit diminishing MRS. Consider the case of goods that are perfect substitutes. That is, the consumer is totally indifferent between good X and good Y. In that case, we would expect indifference curves to be straight lines since the consumer will always be willing to trade one for the other.



This consumer considers Evian and Naya (two brands of bottled water) perfect substitutes and doesn't care whether he has 4 of one and 2 of the other or 3 of both. As long as he has 6 bottles total, he is just as happy. Here, the MRS is 1, because the consumer is always willing to give up *one* bottle of Evian for another bottle of Naya. It is easy to imagine perfect substitutes that have an MRS other than 1, though. A consumer might be indifferent between two 16 oz. bottles of Pepsi and one 32 oz. bottle. The MRS would be 2 since the consumer would always just give up two 16 oz. bottles for one 32 oz. bottle.

Indifference curves will also look "weird" if the goods in question are perfect complements. Goods are perfect complements if they must be used together to produce any utility at all. Thus, increases in the quantity of one good will not produce additional utility without increases in the quantity of another good. For instance, think of a consumer's preferences among right shoes and left shoes.



These perfect complements produce L-shaped indifference curves. If the consumer has, say, one right and one left shoe, another left shoe or two or three more left shoes give this consumer no additional utility at all.

Budget Constraints

Now we know what consumer preferences look like. Of course, consumers cannot buy every potential market basket. Instead, they are limited by their incomes.

The budget constraint shows all combinations of goods for which the total spent is equal to the consumer's income. In other words, it shows all market baskets that the consumer can just barely afford.

The budget constraint is very easy to express mathematically. In our example, there are two goods, food and clothing. Each of these goods presumably has a price. Thus, the total price of a market basket is $P_F F + P_C C$. The consumer can spend up to her income, I , so the budget constraint is

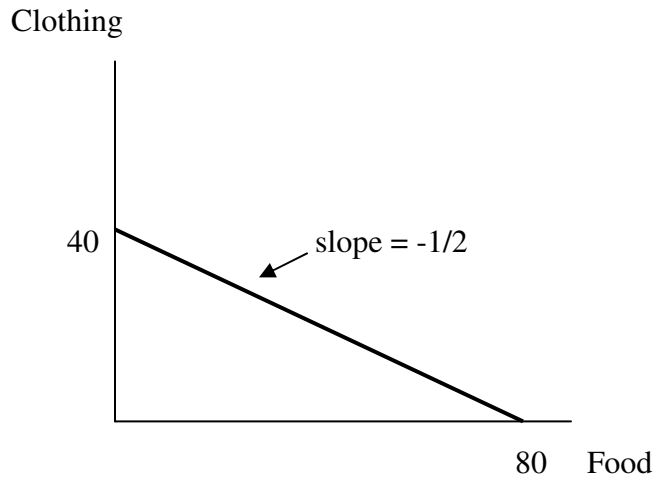
$$P_F F + P_C C = I$$

Following the example in the text, suppose that $P_F = \$1/\text{unit}$, $P_C = \$2$ per unit, and $I = \$80$. In this case, the consumer *could* buy $(F,C) = (80,0)$. Or she *could* buy $(F,C) = (0,40)$. Or $(20,30)$. In all of these cases, the total price of the basket is \$80, completely exhausting her income.

We can also graph the budget constraint. One way to do this is to rewrite it in a more familiar form:

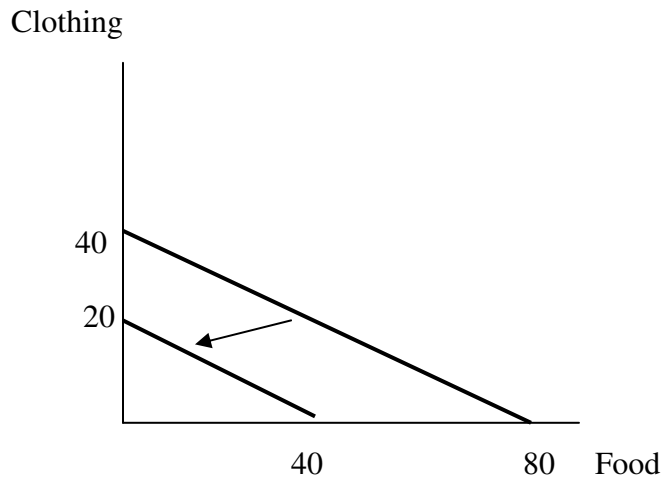
$$C = (I/P_C) - (P_F/P_C)F$$

This shows the budget constraint as a straight line with vertical intercept (I/P_C) , horizontal intercept (I/P_F) and slope $-(P_F/P_C)$. Since we know that the budget constraint will be a straight line, it is easy enough to just find the two intercepts and connect them.



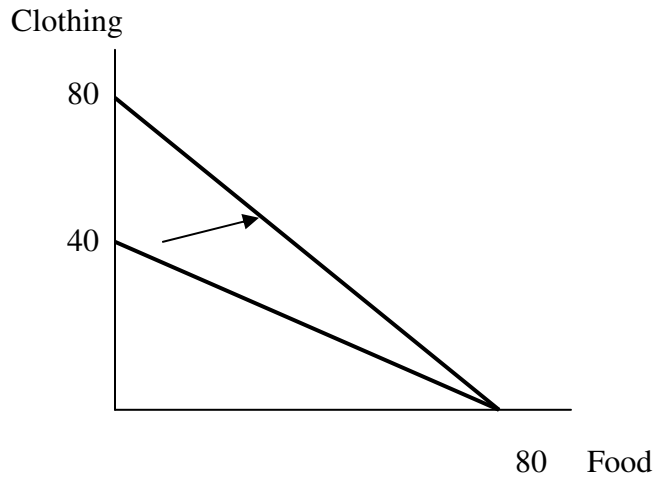
Clearly, the budget constraint depends on prices and income. A change in any of these will cause the budget constraint to shift or rotate.

A Change in Income: If I changes, the budget constraint will shift. Since the slope is $-P_F/P_C$, and neither of these prices have changed, the slope of the constraint stays the same (it is simply a parallel shift). For instance, suppose this consumer's income drops to \$40. In this case, she can now afford $(F,C) = (0,20)$ or $(40,0)$. This new budget constraint lies entirely below the previous one.

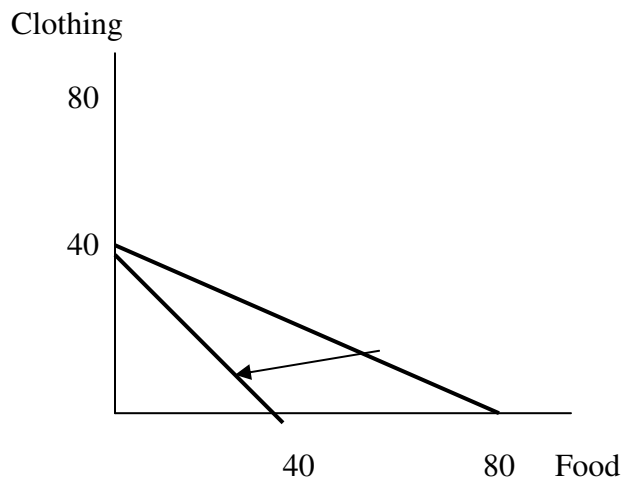


So $\uparrow I \Rightarrow \uparrow$ budget constraint (shifts out and to the right), while $\downarrow I \Rightarrow \downarrow$ budget constraint (shifts in and to the left).

A Change in the Price of One Good: If one good changes in price, the budget constraint will rotate. For instance, suppose that P_C drops to \$1, while food prices remain fixed at $P_F = \$1$. Now the consumer can still buy $(F,C) = (80,0)$ as before. Now, though, the consumer could also buy $(F,C) = (0,80)$ which was unaffordable before. The new budget constraint is therefore:

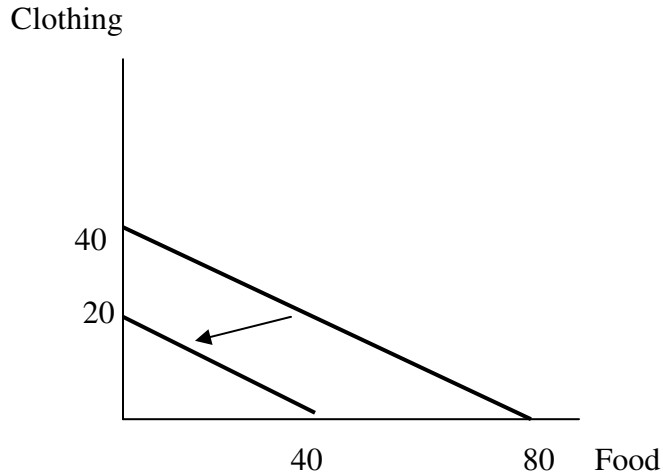


Notice that the slope has changed to $-1/1 = -1$, reflecting the new price ratio. If the price of food had doubled instead to \$2, the price ratio would still be -1 ($-2/2$), but the rotation would have been different.



This time the constraint rotated inward, since food became more expensive.

Note that if the price of both goods changes, you can simply combine these rotations to get the new budget constraint. An interesting case occurs when both prices change by the same factor. Let's suppose that the prices of food and clothing both double, so $P_C = \$4$ and $P_F = 2$. This will not affect the slope of the budget constraint since $-P_F/P_C = -1/2$ still. The new budget constraint would be



Note that this is exactly the same picture that we saw when our consumer's income was cut in half. Since the intercepts of the budget constraint are I/P_F and I/P_C , these intercepts change by the same amount whether I is cut in half or whether both P s double. This reflects the fact that the consumer's purchasing power depends not just on income, but also on prices. If your income stays the "same" and prices all double, your *real* income has been cut in half.

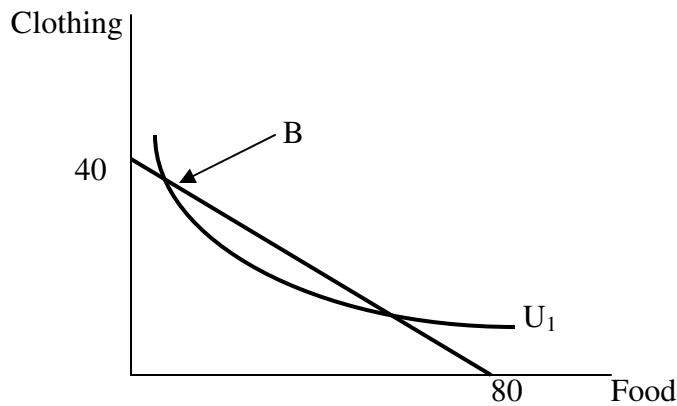
Finally, notice that if everything (both P s and I) change by the same factor, *nothing* changes. If P_C doubles to \$4, P_F doubles to \$2, and I doubles to \$160, you can verify that the consumer can buy exactly the same baskets as she was able to buy before.

Consumer Choice

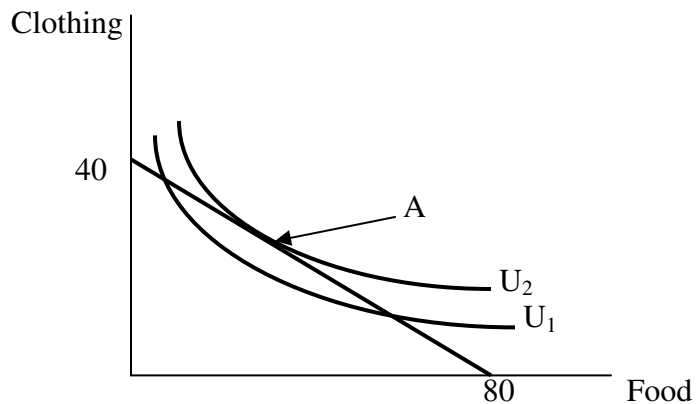
We now know consumer preferences and the constraints faced by the consumer. We can put indifference curves and budget constraints together to examine the actual basket that will be purchased by the consumer. To do this, we first note the following:

- 1) The consumer will purchase a basket on the budget constraint, not below it. This follows from nonsatiation. If the consumer likes a basket below the budget constraint, she can afford to buy more of both goods, a strictly preferred basket.
- 2) The consumer will purchase the basket on the budget constraint that yields the highest level of utility.

Lets stick with $P_F = \$1$, $P_C = \$2$ and $I = \$80$. Consider the following:



Can basket B possibly be the consumer's utility-maximizing choice? No. B lies on indifference curve U_1 , but it is clear that the consumer can afford a basket lying on a higher, more northeasterly indifference curve. In fact, the consumer can continue moving to higher and higher indifference curves, until she reaches one that is just tangent to the budget constraint:



The indifference curve U_2 intersects the budget constraint at exactly one point: point A. It is impossible for the consumer to do any better than this basket, since all other market baskets lying on higher indifference curves also lie outside the budget constraint. Thus, A is the consumer's utility-maximizing bundle and will presumably be purchased.

The general result to get from this is that a rational, utility-maximizing consumer will choose the bundle where the budget constraint is exactly tangent to an indifference curve. Think about what this means. At this point, the slope of the highest indifference curve is exactly the same as the slope of the budget constraint (the definition of tangency). But the slope of the indifference curve is simply the marginal rate of substitution. Thus, our consumer has maximized utility when

$$MRS = P_F/P_C$$

To see why this makes sense, think about what happens if MRS does not equal the price ratio. Obviously this is the case at point B above, where the price ratio is $\frac{1}{2}$ and the MRS is greater, say 1. What does it mean to say that $MRS > P_F/P_C$? Well, if the MRS is 1, the consumer is just willing to give up one unit of clothing to get another unit of food; such a trade-off would leave the consumer's utility unchanged. However, since the price ratio is $\frac{1}{2}$, the consumer only has to give $\frac{1}{2}$ unit of clothing to get another unit of food. So to get one more unit of food, the consumer is *willing* to give up 1 unit of clothing but only *has* to give up $\frac{1}{2}$ unit of clothing. Thus, the consumer could increase her utility by giving up some clothing for more food. Therefore, B could not possibly be utility-maximizing since a bundle with less clothing and more food would be both affordable and preferred to B. Note that this logic holds for *any* point where $MRS > P_F/P_C$.

Consider instead the other intersection of U_1 with the budget constraint. Call this point D. At this point, the indifference curve is flatter than the budget constraint, so $MRS < P_F/P_C$. Suppose $MRS = \frac{1}{4}$, meaning that the consumer is willing to give up 4 units of food to get one unit of clothing. Well, if the price ratio is $\frac{1}{2}$, the consumer only *has* to give up 2 units of food to get a unit of clothing, so she could make herself better off by giving up food and getting more clothing. Point D cannot be the consumer's optimal choice, and the same logic holds for *any* point where $MRS < P_F/P_C$.

The only time there is no tendency for the consumer to substitute is when $MRS = P_F/P_C$. If both these quantities are $\frac{1}{2}$, the consumer *can* trade two units of food for a unit of clothing, but has no particular reason to do so since she is indifferent between an extra unit of clothing and two units of food. No tendency to change \Rightarrow our consumer is as well off as she can be.

In fact, we can go even further than the $MRS = P_F/P_C$ rule. Recall that $MRS = -\Delta C/\Delta F$, or using calculus, $-dC/dF$. Let's define marginal utility (MU) as the additional utility the consumer gets from one additional unit of a good. Thus the marginal utility of one additional unit of food is $MU_F = \Delta U/\Delta F$ (or $\partial U/\partial F$) and the marginal utility of one additional unit of clothing is $MU_C = \Delta U/\Delta C$ (or $\partial U/\partial C$)

How does marginal utility relate to all this? Well, suppose we move along the indifference curve by a small amount, giving the consumer, say, more food and less clothing. The consumer is made better off by $(\Delta F)MU_F$ and worse off by $(\Delta C)MU_C$. Since we are staying on the same indifference curve, $\Delta U = 0$, so

$$\Delta U = 0 = (\Delta F)MU_F + (\Delta C)MU_C$$

Rearranging this gives $-(\Delta C/\Delta F) = MU_F/MU_C$.

(If we were using calculus, we would totally differentiate $U(F,C)$ to get

$$0 = (\partial U/\partial F)dF + (\partial U/\partial C)dC$$

and rearrange to get

$$dC/dF = MU_F/MU_C$$

But the left-hand side expression is just MRS! So using our rule that $MRS = \text{price ratio}$, we get the following:

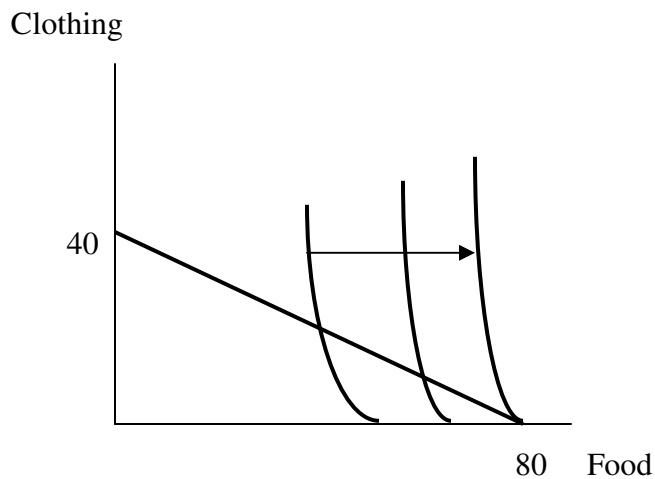
$$MU_F/MU_C = P_F/P_C$$

or

$$MU_F/P_F = MU_C/P_C$$

This rule must hold for a utility-maximizing consumer, and says simply that the consumer must be buying products such that marginal utility per dollar spent is the same for all products. Otherwise, the consumer would do better to spend \$1 less on one product (with the lower MU/\$) and spend \$1 more on the other (with the higher MU/\$). As the consumer buys less of the first product, MU rises, while as the consumer buys more of the second product, MU falls, bringing us to the equation above.

One caveat to this condition is the possibility of a corner solution. If the consumer has especially steep or flat indifference curves, she may be unable to set MRS exactly equal to the price ratio, but she will do as well as possible by buying a basket composed of entirely one good. For example:



This consumer's indifference curves are very steep, indicating a strong preference for food (the consumer is willing to give up a fairly large amount of clothing for additional food – very high MRS).

Because the MRS is so high, higher than the price ratio, she keeps buying more and more food until she has exhausted her budget. At this point, MRS is still greater than the price ratio, but the consumer has no more money to spend and can do no better than this corner solution.

If her indifference curves were particularly flat, she would maximize utility by choosing to buy nothing but clothing.

In these corner solutions, the $MRS = P_F/P_C$ rule is *not* satisfied. The rule will always be satisfied with interior solutions, though.

Applications/Examples