4. The Theory of Incentives: Consumer Behavior

In this chapter you will learn:

- Consumer economic decisionmaking;
- Utility;
- Diminishing marginal utility;
- Budget constraints
- Derivation of demands and Engel curves;
- Consumer responses to price and income;
- Unusual consumer effects
- Housing, taxes, and consumer decisions

4.1 Introduction

It is important to go behind the market supply and demand curves to understand the behavior that generated each curve. Why? It helps us understand the properties of the supply and demand curves and in turn this helps us understand how the market works and what might happen if it doesn't work properly. Why does the demand or supply curve have the slope it has? Why does the demand curve shift when income or some other variable changes? Why does the supply curve shift when labor costs rise, or when the EPA imposes new regulations? There are a number of factors that can influence a market, e.g., foreign competition, tax policy, economic growth, a buyout or merger of two companies, introduction of a new technology, environmental regulations. One needs to understand how the market will respond to these factors and to get at that we need to study what generates the demand and supply curves.

One of the things we know about economic behavior is that people typically respond to the incentives they face. If one knows the incentives that firms or consumers confront, one can predict how they will behave. For example, if a loan officer working for a bank receives an end-of-the-year bonus that is inversely tied to the number of foreclosures they experience in their loan portfolio, they will take great care in making a loan to minimize foreclosures and maximize their bonus. On the other hand, if their bonus is simply tied to how many loan contracts they sign with potential borrowers, they won’t be as careful in making a loan. They would sign as many loans as they could regardless of the risk. It would not be surprising to observe a higher foreclosure rate under the second incentive system rather than the first.¹

As another example, consider shirking behavior on the job. Workers typically do not like to work and will try to shirk their responsibility whenever they can. Unfortunately, it is costly for managers to monitor their workers. It may not be immediately obvious when a worker has shirked. For example, a machine can break down because the worker was not carefully watching it but off somewhere taking a long coffee break, or the machine can simply break down of its own accord even while being carefully maintained by the worker. It may be difficult for a manager to know which happened. This is the essence of the shirking problem.

¹ This is documented by S. Agarwal and I. Ben-David in their paper, “Do Loan Officers’ Incentives Lead to Lax Lending Standards?,” Discussion Paper, 2012. Countrywide Financial, the largest mortgage originator in the 2000s, based bonuses on the number of loan contracts signed, rather than the safety of the loans. They packaged the mortgages and sold them to investment banks who then used them to sell derivatives. After the financial collapse it became known that many of the loans made by Countrywide were based on false information given to the loan officers by borrowers regarding the borrower’s income. These became known as “liar loans” and led to a large number of foreclosures and the collapse of Countrywide during the crisis of 2008, whose viable assets were purchased by Bank of America. Countrywide called this incentive system, “The Hustle” and pushed its use aggressively. See http://dealbook.nytimes.com/2013/10/23/jury-finds-bank-of-america LIABLE-in-mortgage-case-nicknamed-the-hustle/
There are different incentive systems one could use in paying workers. Suppose the worker is paid a fixed amount by the hour regardless of how much the worker produces. Under this incentive system, the worker has no incentive to work hard and be productive, and may shirk his duties. Now suppose the worker is paid by how much he produces instead. He has more of an incentive to keep his machine in good working order and produce a lot. Tying the worker's pay directly to his productivity changes the incentive he faces and workers generally respond by producing more. End-of-the-year bonuses provide yet another example of an incentive system. Many firms pay executives and middle level management bonuses at Christmas time based on their performance. This may provide managers with an incentive to produce more.2

This same problem arises in many public policy debates. For example, under one set of incentives, those receiving unemployment compensation after losing a job may have an incentive to remain out of the work force.3 Under another set of incentives, they may try to look for work as soon as possible. Studying the difference between the two systems is critical to the public policy debate on unemployment compensation during a recession.

There are plenty of examples of this sort of behavior. A child needs an incentive not to beat up his little brother and take his GI Joe with the kung fu grip. Students need an incentive to study and learn. Drivers need an incentive to stop at red lights. Taxpayers need an incentive to pay their taxes. Politicians need an incentive to act in the public's best interest. A country needs an incentive not to attack another country to steal its resources.

4.2 Preferences: Indifference Curves
There are two parts to the theory of consumer behavior, tastes or preferences and the budget constraint. First, we will discuss the consumer's tastes and then the consumer's budget constraint.

We will assume the consumer has a taste for various goods and services because they provide the consumer with happiness or satisfaction, sometimes called utility. We will make the following assumptions. The consumer's preferences are fixed and unchanging, and the consumer is rational and makes her choices in her own best interest. So someone who likes coffee will have coffee enter their utility function. However, this idea can be broadly defined to include quite a bit. For example, we could assume parents care about their children altruistically and still consider this rational. We could also develop a theory of donating to charity based on the individual's own self interest if "self interest" is broadly defined to include caring about other people. In fact, this is the only way to explain the surge of flower sales on Mother's Day, or the increase in sales of chocolate on Valentine's Day.

In addition to this, we make two critically important assumptions. First, more is preferred to less. So, for example, if we give a consumer a free gift of goods that she is already consuming, she is better off as a result. Second, we assume the consumer is willing to accept tradeoffs among the goods she consumes. She is willing to give up some of one good to obtain some of another. These assumptions are embodied in what we call "indifference curves."

2 Pay tied to performance is related to “piece work,” which has a bad connotation. In the 19th and early 20th centuries women were hired to produce products like shirts and pants using a new invention, the foot powered sewing machine. Many worked in large “sweat” shops and were terribly exploited before state governments, and later the federal government, passed laws protecting them, e.g., restricting hours, allowing breaks and lunches, and providing for the safety of the workers. This occurred after the terrible tragedy of the Triangle Shirtwaist Factory fire in NYC in 1911 where 145 workers, mostly women, burned to death after being locked in the factory without a fire exit.

3 Welfare programs in Denmark, Sweden, and the Netherlands used to be very lucrative. When a worker lost their job they could receive significant unemployment benefits. This may have given them an incentive not to find a new job right away. The government in Denmark revised its welfare rules in 2010 in response to this problem.
Mathematically, we can represent the consumer's utility or happiness as a function of the goods consumed according to
\[ u = U(x_1, x_2, \ldots, x_{10123}), \]
where the consumer consumes \( x_1 \) units of the first good, e.g., coffee, \( x_2 \) units of the second good, e.g., hamburgers, and so on, and \( x_{10123} \) units of good number 10,123, e.g., chocolate. For simplicity, we will assume there are only two goods, \( x_1 \) and \( x_2 \), since this will facilitate graphing. The theory does not depend on this simplifying assumption, however. So, to simplify, \( u = U(x_1, x_2) \) will represent the consumer's happiness or utility from consuming \( x_1 \) and \( x_2 \).

Suppose we consider the following thought experiment. Suppose \( x_1 \) is hamburgers, and we fix \( x_2 \) and increase \( x_1 \). Suppose the consumer eats one hamburger and obtains 10 units of utility or happiness. His "extra" utility from consuming the first hamburger is 10. This is the consumer's \textit{marginal utility} or extra utility from consuming the first hamburger. Suppose the consumer eats a second hamburger. The two hamburgers together produce 14.142 units of happiness. So the second hamburger produces an extra 4.142 units of happiness or utility. Suppose he continues consuming hamburgers and receives the extra utility as depicted in the table below. Notice that utility is increasing until the fifth hamburger but the extra or marginal utility the consumer receives is less and less. This illustrates the \textbf{law of diminishing marginal utility}, which is similar to the law of diminishing marginal returns we studied in Chapter 2.

<table>
<thead>
<tr>
<th>Hamburger (x1)</th>
<th>Total Utility (x1)</th>
<th>Marginal Utility (x2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>14.14213562</td>
<td>4.142135624</td>
</tr>
<tr>
<td>3</td>
<td>17.32050808</td>
<td>3.178372452</td>
</tr>
<tr>
<td>4</td>
<td>20</td>
<td>2.679491924</td>
</tr>
<tr>
<td>5</td>
<td>22.36067977</td>
<td>2.360679775</td>
</tr>
</tbody>
</table>

More formally, we can define the marginal utility of any good \( X \) as \( MU_X = \Delta U / \Delta X \). Increase consumption of \( X \), \( \Delta X > 0 \), and measure the change in utility, \( \Delta U \). For good one, \( MU_1 = \Delta U / \Delta x_1 \), and similarly for good two, \( MU_2 = \Delta U / \Delta x_2 \). The \textbf{MU} \textit{is decreasing as} \( x_1 \) \textit{increases}, holding everything else constant, so \( \text{corr}(MU_1, x_1) < 0 \), when there is diminishing marginal utility to consuming \( x_1 \). As \( x_1 \) increases \( MU_1 \) falls, as \( x_1 \) falls \( MU_1 \) increases.

We can illustrate the three important concepts of diminishing marginal returns, more is preferred to less, and that tradeoffs in consumption exist in the following example. Let utility be given by
\[ u = \sqrt{x_1x_2}. \]

Suppose we fix consumption of the second good at \( x_2 = 100 \). Then
\[ u = \sqrt{x_1100} = \sqrt{100x_1} = 10\sqrt{x_1}. \]

Now consider increasing the consumer's consumption of the first good according to \( x_1 = 9, 16, 25, 36, \) and \( 49 \). Our goal is to calculate the consumer's marginal utility from this consumption. Total utility increases according to 30 (\( u = 10\sqrt{9} = 10 \cdot 3 = 30 \)), 40, 50, 60, and 70.

What is the marginal utility of the extra consumption of good one? \( \Delta u / \Delta x_1 = (40 - 30)/(16 - 9) = 10/7, (50 - 40)/(25 - 16) = 10/9, (60 - 50)/(36 - 25) = 10/11, (70 - 60)/(49 - 36) = 10/13. \)

\[ u \] is utility or happiness and \( U(x_1, x_2) \) is a function that tells us what utility depends on, \( x_1 \) and \( x_2 \), for example. If the consumer cares about coffee and mac and cheese, \( u = U(\text{coffee, mac and cheese}). \)
Intuitively, the consumer must consume more and more to get the same increase in utility so 
**marginal utility is diminishing.** Alternatively, suppose consumption of the first good increases 
according to $x_1 = 100, 101, 102, 103, 104,$ and $105$. Then total utility changes according to $u = 100, 100.498, 100.995, 101.489, 101.98,$ and $102.469$. Marginal utility changes according to $MU_1 = 0.498 = \frac{(100.498 - 100)}{(101 - 100)}$, $0.496$, $0.494$, $0.491$, and $0.489$. Total utility is 
increasing, but at a diminishing rate so marginal utility is diminishing.

As an aside, it is possible for the marginal utility to increase at first. Why? Suppose you are 
exceptionally hungry. The first hamburger you consume will provide you with a lot of utility, 
e.g. $TU = total \ utility = 73$ and $MU = 73$. It is possible that you are so hungry that the second 
hamburger may provide you with even more utility at the margin, e.g., $MU = 77$ from the second 
hamburger so $TU = 150$ from two hamburgers. It appears that this violates the law of 
diminishing marginal utility since $77 > 73$. However, if you keep eating hamburgers, eventually 
the extra utility you receive will diminish. By the fifth hamburger, for example, $MU = 5 < 73$.

Second, **more is preferred to less.** As consumption of the first good, the second good, or both 
increases, utility increases so the consumer is better off. As consumption of good one increases, 
utility increases according to $100, 100.498, 100.995, 101.489, 101.98,$ and $102.469,$ and similarly 
if good two increases. Suppose consumption of both goods increases from 49 units to 100. Then 
utility increases from 49 to 100. This illustrates that more is preferred to less. To see this note 
that $49 = \sqrt{49 \cdot 49}$ increases to $100 = \sqrt{100 \cdot 100}$.

Third, **there are tradeoffs in consumption.** Notice that the bundle $(x_1, x_2) = (25, 1)$ produces 
the same level of utility as the bundle $(x_1, x_2) = (1, 25)$. This means that if the consumer starts off 
with the first bundle and we take away 24 units of the first good, we can compensate him by 
giving him 24 units of the second good. He can achieve the same level of utility as before. The 
two bundles $(25, 1)$ and $(1, 25)$ are **equivalent** in the sense that they produce the same utility. If 
the consumer were given a choice between the two, he would be **indifferent** between them 
because they are equivalent. As it turns out, there is a large number of bundles that produce the 
same level of utility. The graph of all of them is called an indifference curve because the 
consumer is indifferent as to which one he consumes; they are all equivalent as far as he is 
concerned.

Consider graphing the indifference curves of the utility function, $u = \sqrt{x_1 x_2}$. To graph one of 
the indifference curves, choose a value for $u$ and pick different bundles of consumption, or 
ordered pairs $(x_1, x_2)$, that satisfy the equation. Let $u = 25$. Then $25 = \sqrt{x_1 x_2}$. The ordered pairs
(125, 5), (5, 125), and (25, 25) satisfy the equation and are graphed below. Any point on the curve yields the same amount of utility. The consumer is indifferent between any of the points on the curve because she is equally happy with any of them. Once again, the curve is called an **indifference curve**; all the points on the curve are equivalent from the consumer's perspective so she is indifferent between any two points on the curve.

Suppose the consumer is consuming 25 units of each good so we're at point A in the figure below and we give the consumer 24 more units of each good. The consumer's utility increases from 25 to $49 = 25 \times 49$ and she moves from point A to point B in the diagram on the right. She is consuming more of both goods and is better off. There is another indifference curve that goes through point B and all of the points or consumption bundles on it are equivalent to one another in the sense that they generate the same level of utility, $u = 49$. Utility or satisfaction is increasing in the direction of the arrow since more is preferred to less. Furthermore, any bundle of $x_1$ and $x_2$ on the "B" curve is better than any bundle on the "A" curve. Why? Bundles B and B' are equivalent in the sense that they produce the same amount of utility for the consumer. And bundles A and A' are also equivalent to one another for the same reason. However, B is preferred to A. Since B' and B are equivalent, it follows that B' must be preferred to A. But since A' and A are equivalent, B' must also be preferred to A'. This is true for any bundle on the "B" curve when compared to any bundle on the "A" curve.

**Remember: more is preferred to less and psychological tradeoffs exist in consumption.** The indifference curves slope downward to reflect the notion that tradeoffs exist and higher indifference curves yield more utility since more is preferred to less. The first quadrant of Euclidean space is filled with indifference curves like the two curves depicted in the right hand diagram above. The entire collection of curves is called the **indifference map**.

Consider starting at point A and taking away some $x_2$ from the consumer, so $\Delta x_2 < 0$, depicted on the vertical axis. Obviously, the consumer will be worse off. However, suppose the consumer
tells us how much \( x_1 \) she requires in order to be as well off as before and she says one unit, \( \Delta x_1 = 1 \), which is depicted on the horizontal axis.

We can define the **marginal rate of substituting** \( x_1 \) **for** \( x_2 \) as minus the ratio of \( \Delta x_2 \) to \( \Delta x_1 \),

\[
\text{MRS(} x_1 \text{ for } x_2 ) = - \frac{\Delta x_2}{\Delta x_1}.
\]

Alternatively, suppose we give her one more unit of \( x_1 \) and ask her how much \( x_2 \) she is willing to give up for it. The answer is the MRS since she is substituting the first good for the second good. For example, suppose the consumer is willing to give up 3 units of \( x_2 \) (\( \Delta x_2 = -3 \)) in order to get one unit of \( x_1 \) (\( \Delta x_1 = 1 \)). Then, the MRS = \(- (-3)/(1) = 3\).

Notice that when she has a lot of \( x_2 \) she is willing to give up a lot to get more \( x_1 \), as in the move from point A to point B. However, when the consumer has only a small amount of \( x_2 \), she is less willing to give it up to get more \( x_1 \), as in the move from point C to point D. This illustrates the **law of diminishing marginal rate of substitution**. At A she has a lot of \( x_2 \) and little \( x_1 \). She is willing to give up a lot of \( x_2 \) to get one more unit of \( x_1 \) simply because she has a lot of \( x_2 \) to begin with. At point C this is no longer true and she becomes less willing to sacrifice \( x_2 \) for one more unit of \( x_1 \).

It is straightforward to derive the following,

\[
\text{MRS} = - \frac{\Delta x_2}{\Delta x_1} = \frac{MU_1}{MU_2}
\]

where \( \frac{\Delta x_2}{\Delta x_1} = - \frac{MU_1}{MU_2} \) is the **slope of the indifference curve** at a point like A in the diagram above, for example. (The derivation is in the Appendix.)

### 4.2.2 Special cases

There are two special cases of interest: Constant MRS or the case of **perfect substitutes**, and an undefined MRS or the case of **perfect complements**. For the case of perfect substitutes, there is a constant tradeoff all along an indifference curve. For perfect complements, there is no acceptable physical tradeoff. When there is a constant tradeoff, the indifference curve is a straight line and the slope is constant. For the case of perfect complements, there is no acceptable tradeoff so the indifference curves are "L-shaped." The consumer will always choose to be at a corner of the "L."

**Example: perfect substitutes**: Folgers coffee and Hills Bros., pencil and pen, ice cream and frozen yogurt, blue cars and black cars, chicken fingers and chicken nuggets, jeans at Walmart and jeans at Shopko.

**Example: perfect complements.** Paper and pen, sugar and coffee, right shoe and left shoe, pants and belt, gin and tonic and lime, chicken fingers and honey mustard sauce.

**Application:** The coffee, cream, and sugar you enjoy are complementary goods. You have to have them in just the right proportion in order to enjoy your beverage. Then along comes the waiter/waitress and dumps more coffee in your cup as he/she asks, "Want some more coffee?" Getting more coffee doesn’t increase your utility unless you also get extra cream and sugar.
4.2.3 Some examples

Food and entertainment
Let $F =$ food, $E =$ entertainment. Utility is given by $U = U(\text{food}, \text{entertainment})$, or in short, $U = U(F, E)$. We can put food on the horizontal axis and entertainment on the vertical axis.

Housing and consumption
Let $h =$ housing, $c =$ consumption and let $U = U(h, c)$ be utility. We can put $h$ on the horizontal axis for $x_1$ and $c$ on the vertical axis for $x_2$. The indifference curves have the usual shape. As a specific example, $U = (h \times c)^{1/3}$. Consider $h = 25$, $c = 5$. Utility is $U = (125)^{1/3} = 5$. Next, consider $h = 5$, $c = 25$. This also produces $U = 5$. These two bundles $(25, 5)$ and $(5, 25)$ are equivalent.

Leisure and consumption
Let $L =$ leisure, $C =$ consumption. Utility is given by $U = U(\text{leisure}, \text{consumption})$, or $U = U(L, C)$. Replace $x_1$ with $L$ and $x_2$ with $C$. More specifically, let utility be given by $U = (L \times C)^{1/2}$. Consider two bundles and calculate utility: $L = 4$, $C = 4$ leads to $U = (4 \times 4)^{1/2} = 4$ and $L = 8$, $C = 2$ also leads to $U = 4$. The bundles $(4, 4)$ and $(8, 2)$ are equivalent. How do you go from $L = 4$ to $L = 8$? By working less and taking more leisure. Consumption falls when this happens.

Consumption over time
Suppose there are two periods, period 1, now, and period two, the future. Let $C_1 =$ consumption now, or $x_1$, and $C_2 =$ consumption in the future, or $x_2$. Utility is $U = U(C_1, C_2)$. Usually when the future is included in the model, we discount future utility. Let $\beta =$ discount factor, where $0 < \beta < 1$. Specifically, the utility of $C_1$ and $C_2$ at the beginning of the planning period is $u = U(C_1) + \beta U(C_2)$. Consumption in the future is not worth as much to you today as the same consumption today. Why? Because it happens in the future. The smaller $\beta$ is, the less you care about the future and the smaller the amount of utility produced by consumption in the future. This might be one explanation why people in the US don’t save as much as they once did. They might simply have a lower $\beta$ now than fifty years ago.

4.2.4 The Case of "Bads"
There are some goods that people do not like but are sometimes forced to consume. Suppose you hate to travel but must travel on business. Travel leads to lower utility. Suppose, for simplicity, that you consume two "commodities," travel, which you do not like, and everything else, which you do enjoy. Then, $u = U(\text{travel}, \text{everything else})$. Travel lowers utility, everything else raises it. In this case, you actually need more of the good "everything else" to compensate you when you are forced to consume more of the good "travel." Utility is increasing in the direction of the arrow below because "travel" is a "bad" and not a "good." If you flip the axes, the curves are inverted but provide us with the same information.
Note: Put "travel" on the horizontal axis and "everything else" on the vertical axis. The marginal utility of travel is negative; as you are forced to increase your consumption of travel, your utility goes down, i.e., $\text{MU}_{\text{travel}} < 0$. However, you gain utility from "everything else" so $\text{MU}_{\text{everything else}} > 0$. Therefore, $\text{MRS} = \frac{\Delta \text{everything else}}{\Delta \text{travel}} = - \frac{\text{MU}_{\text{travel}}}{\text{MU}_{\text{everything else}}} > 0$, since $\text{MU}_{\text{travel}} < 0$. The indifference curves slope upward!

**Example:** If $\text{MU}_{\text{everything else}} = 2$, $\text{MU}_{\text{travel}} = -5$, then $\text{MRS} = - \frac{2}{-5} = 2/5$, which is positive as expected.

**Application:** Finance. Suppose there are two assets, one has a higher payoff than the other on average but is more risky. Investors are willing to trade off the mean rate of return for incurring more risk. More risk must be compensated by a higher mean return as you move along an indifference curve. However, an increase in the mean return and a decrease in risk, a move in the direction of the arrow below, improves utility because the "good," mean return, has increased while the "bad," risk, has decreased. So $U = u(\text{risk}, \text{mean return})$, where risk is a "bad" and mean return is a "good." To extend this to two assets, the utility payoff might be given by,

$$U = u(\text{risk}_1, \text{mean return}_1) + u(\text{risk}_2, \text{mean return}_2),$$

for assets #1 and #2. Two assets might yield the same utility payoff even though they have different risks if the returns differ. For example, #1 might yield the same utility payoff as #2 even though $\text{risk}_1 > \text{risk}_2$ as long as $\text{mean return}_1 > \text{mean return}_2$.

![Indifference Map](image)

### 4.3 The Income Constraint

Notice that if more is preferred to less, the consumer would want to consume more of most goods and move in a northeasterly direction in her indifference map. She cannot do this, however, because of the second element of the consumer's decision making process, the budget constraint. To keep matters simple, let $I$ be income, $p_1$ be price per unit of good one, and $p_2$ be price per unit of good two. Then $p_1x_1$ is expenditure on good one, $p_2x_2$ is expenditure on good two, and $p_1x_1 + p_2x_2$ is total expenditures on both goods. Finally, if more is preferred to less, the consumer will spend her entire income so $I = p_1x_1 + p_2x_2$, i.e., income will equal expenditures. This is the consumer's income constraint.

We will assume the consumer takes income and prices as determined beyond her control. This is obviously not true for all prices, nor is it always true for income. However, as an approximation, it will lead to a rich theory of consumer behavior and serves as a useful starting point. We can develop a theory of income determination that links a person's choices involving education and her wage and hence her income, and we can develop a theory of bargaining, say, over the price of a car. For now, however, we will assume $I$, $p_1$, and $p_2$ are fixed to the consumer.
If I, p₁, and p₂ are fixed, the budget equation can be graphed as a straight line, the budget line. To graph the consumer's budget constraint find the two intercepts: (I/p₁, 0) and (0, I/p₂). The budget line is the straight line connecting the two intercepts. This is depicted in the left diagram of the figure below.

We will assume the consumer's tastes are fixed. This means the indifference curves are fixed and cannot change. We will also assume the budget line can shift around; income and prices can change. We will use shifts of the budget line to explain why people change their consumption pattern. So it is important to know how the budget line shifts in response to a change in income or a price.

The key is determining how the intercepts respond. First, notice that income enters both intercepts in the same way. So an increase in income increases both intercepts in the same way. This causes the budget line to shift out in a parallel manner; the slope doesn't change. An increase in income causes the budget line to shift out in a parallel way, while a decrease in income causes the budget line to shift back in a parallel way.

Second, a change in both prices by the same percentage alters both intercepts in the same way. For example, if both prices double, both intercepts decrease by half and the budget line shifts back in a parallel way just as it would if income had fallen. An increase in all prices is called inflation. Thus, inflation is "like" a decrease in income.

Finally, if only one price changes, the budget line will swivel because only one intercept will change. Suppose p₁ falls. Then I/p₁ increases and the budget line swivels out as in the diagram on the right. This changes the slope. If p₁ increases, the slope increases and the budget line gets steeper. If p₁ decreases, the slope decreases and the budget line gets shallower.

Intuitively, the budget line plays the same role for the consumer as the production possibilities frontier does for society; it forces choices to be made. The consumer can consume at point A in which case she is not spending all of her income. She cannot consume at point C because she doesn't have enough income. She is spending exactly all of her income at point B. Income generally increases with economic growth. So with growth she might eventually be able to afford point C if her income or budget line shifts out enough.

Note that the slope of the budget line is: \[ \frac{\Delta x_2}{\Delta x_1} = -\frac{p_1}{p_2} = -\text{MRT}, \] where the price ratio of p₁ to p₂ is defined as the marginal rate of transforming (MRT) x₂ into x₁, i.e., \[ p_1/p_2 = \text{MRT}. \] This is determined by the market, whereas, the MRS, the marginal rate of substitution, is psychological; the MRS is determined by the consumer's own tastes.

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5 To find (I/p₁, 0), the intercept on the horizontal axis, set \( x_2 = 0 \) and notice that the constraint becomes \( I = p_1x_1 \), and solve for \( x_1 \). Similarly for the vertical intercept: set \( x_1 = 0 \) and solve the resulting equation for \( x_2 \).
4.4 Optimizing Behavior.

Our basic assumption is that the consumer wants to choose her economic behavior so as to maximize her utility subject to her budget constraint. Suppose we start the consumer at point A. Two things are true of point A. First, point A is on an indifference curve, and second, point A is on the budget line so the consumer could afford the consumption bundle at A. Will she stay at point A? No. She can move to B and increase her utility because she is moving to a higher indifference curve. She can also afford to buy B as well. Will she stay at B? No, because she can do even better by moving to C. Will she move to D? No, because her utility would decrease. Point C is the best she can do.

Notice that at point C the slopes of the indifference curve and the budget line are the same. The slope of the indifference curve at C is $\frac{\Delta x_2}{\Delta x_1} = -\text{MRS} = -\frac{\text{MU}_1}{\text{MU}_2}$. The slope of the budget line at C is $\frac{\Delta x_2}{\Delta x_1} = -\text{MRT} = -\frac{p_1}{p_2}$. At point C the slopes are equal. Therefore, at C, $\frac{\text{MU}_1}{\text{MU}_2} = \frac{p_1}{p_2}$, or, rearranging

Optimizing Rule: $\frac{\text{MU}_1}{p_1} = \frac{\text{MU}_2}{p_2}$.

If the consumer chooses her consumption of the two goods so this rule holds, then she will be maximizing utility subject to her constraint.

The last equation is the rule guiding the consumer's optimal choice of consumption. How can we interpret this rule? The **MU is the extra benefit** from consuming a unit of a particular good. The **price of the good p is the cost** that must be paid. Thus, the ratio $\frac{\text{MU}}{p}$ is the ratio of the extra benefit to the cost of consuming one more unit of the good. The rule for optimizing behavior indicates that the **consumer should choose her consumption pattern so the benefit to cost ratio is equal across goods**.

The consumer can do no better by following some other rule or by choosing another consumption bundle. To see this, suppose $\frac{\text{MU}_1}{p_1} > \frac{\text{MU}_2}{p_2}$. Then $\frac{\text{MU}_1}{\text{MU}_2} > \frac{p_1}{p_2}$ is also true (by 9th grade algebra). Hence $\frac{\text{MU}_1}{\text{MU}_2} < \frac{p_1}{p_2}$. This last statement says that the slope of the indifference curve is steeper (more negative) than the slope of the budget line. (This
is a point like A or B in the diagram above.) Suppose the consumer increases \( x_1 \) and lowers \( x_2 \). Then we know that \( MU_1 \) decreases as \( x_1 \) increases because of diminishing marginal utility and \( MU_2 \) increases because \( x_2 \) decreases for the same reason. (MU increases if \( x \) goes down and vice versa when \( x \) goes up when there is diminishing MU.) Then \( MU_1/p_1 \) decreases as \( x_1 \) increases while \( MU_2/p_2 \) increases as \( x_2 \) decreases. This will continue until the inequality is an equality once again. But then the consumer will be at point C where the slopes are the same. In the following example we look at the case where \( MU_1/p_1 < MU_2/p_2 \) at point D above.

Example: Suppose we have the following data, \( p_1 = 1, p_2 = 4, MU_1 = 7, MU_2 = 30 \)

Then \( MU_1/p_1 = 7 < 7.5 = MU_2/p_2 \) and we are at a point like D in the diagram above. What should the consumer do? From the data \( MU_1/MU_2 < p_1/p_2 \), or \( -MU_1/MU_2 > -p_1/p_2 \) so the budget line is steeper than the indifference curve. The optimizing rule tells the consumer to reduce \( x_1 \) since this will cause her \( MU_1 \) to increase and increase \( x_2 \) since this will lower her \( MU_2 \). She will move in the direction of the arrows until she reaches a point of tangency between an indifference curve and the budget line.

Example: Suppose \( MU_{\text{house}} = 4000, P_{\text{house}} = \) rental price of a house = $400, and \( P_{\text{movie}} = $8 \), what is the \( MU_{\text{movie}} \) if the consumer is behaving optimally? Use the rule: \( MU_{\text{house}}/P_{\text{house}} = MU_{\text{movie}}/P_{\text{movie}} \) or \( 4000/400 = MU_{\text{movie}}/8 \), so \( MU_{\text{movie}} = 80 \).

Example: Suppose the price of a movie is $10, the marginal utility of a song on iTunes is 3, and the marginal utility of a movie is 30. What is the price of a song at iTunes if the consumer is behaving optimally? Use the optimizing rule: \( MU_{\text{movie}}/P_{\text{movie}} = MU_{\text{song}}/P_{\text{song}} \) to obtain \( 30/10 = 3/P_{\text{song}} \) and solve \( P_{\text{song}} = $1 \).

Example: If the marginal utility of a BMW is 20,000 and the marginal utility of french fries is 1/2 per serving, what is the MRT between BMW's and french fries, assuming the consumer is optimizing? The MRS of BMW's for french fries = \( MU_{\text{BMW}}/MU_{\text{frenchfries}} = 20,000/(1/2) = 40,000 \) and MRS = MRT so MRT = 40,000. If french fries cost $1 per serving, then \( P_{\text{BMW}} = $40,000 \). Grab the deal while they last!

Let's consider another case, that of perfect substitutes. Suppose a consumer feels that HBO and Showtime are perfect substitutes. In that case, the indifference curves will be straight lines as depicted on the left below. Superimpose the budget line onto the indifference curves as depicted by the thick line in the right hand diagram between points A and A'. Given the budget line denoted by the thick line, where will the consumer choose to be if she maximizes her utility? Suppose she picks point c. Is that the best she can do? No. She can move to a higher indifference
curve by moving to point b. However, she won't stop there. She can attain an even higher level of utility by moving to point a, where she will only watch HBO and not Showtime. Notice that the budget line is really steep. This tells us that the price of the good on the horizontal axis, in this case, Showtime, is greater than the price of the other good, HBO. So the theory predicts that for perfect substitutes the consumer will only consume one of the goods, the one that is relatively cheaper. Only if the indifference curve lies directly on top of the budget line might the consumer choose to consume both goods. But, in that case, a small change in price will cause the consumer to shift completely to the cheaper good.

4.5 Modeling Philosophy
Do consumers actually undertake these complicated calculations? Do they actually sit down, write out their utility function and their budget equation and try to figure out what they should consume by mechanically calculating their "optimal" bundle? Obviously not. Then what good is this theory if it's so unrealistic? A map is an unrealistic model of a city but may be very good at making predictions: A = map, TC = choose a route and walk it, P = you'll arrive at your destination.

Our theory of consumer behavior, and later our theory of the firm, is similar in spirit to this. We are constructing a hypothetical model of consumer behavior in order to make predictions about the consumer's behavior. How will the consumer respond to a higher price? How will she respond when she gets a raise or loses her job? How does the tax system affect relative prices and hence her consumption pattern, and so on? And just as pool players do not use complicated mathematics, neither do consumers. However, our model is a stylized description of the consumer's behavior. It can only be judged on the basis of its predictions.

4.6.1 Tastes.
Most advertising is aimed at changing tastes. Suppose the indifference curves swivel and become flatter in response to an effective advertising campaign by producers of $x_1$. The consumer will shift from a to b hence from $x_2$ toward $x_1$, which is what sellers of $x_1$ are after.

Example: Tastes might change as a person ages. The elderly person has a greater taste for medical care than when she was younger. The workaholic business executive might have been the lazy teenager. The teenager who thinks that ballet isn't cool might end up standing in line as an adult waiting to buy tickets to the Nutcracker.
The main problem with relying on changes in tastes to explain consumer behavior is that tastes are impossible to observe and we cannot reliably predict when they will change. This would not lead to a fruitful theory.

4.6.2 Income: Normal goods.
Suppose income increases. The budget line will shift out in a parallel way. New tangency points will be picked up like point B. At each tangency point the consumer is behaving optimally, i.e., maximizing utility subject to her budget. A curve connecting all of the tangency points can be traced out. It is known as the income consumption curve because income is changing and that is causing a change in the consumer's consumption pattern. Each tangency point corresponds to a point in income-$x_1$ space and income-$x_2$ space. Thus, points A and B match up in all three diagrams below.

Example: $x_1$ = health care, $x_2$ = travel As income increases people consume more health care and travel more.

You can now see where the Engel Curve comes from. Start at point A in the first diagram and simply track the consumer's behavior as income increases. Since both $x_1$ and $x_2$ are increasing as income rises, they are both normal goods and both Engel curves slope upward on the right as a result.

4.6.3 Income: Inferior good.
Notice that as income increases in the diagram on the left below, more $x_1$ is consumed but less $x_2$ is, i.e., as income increases, we move from A to B on the "income consumption" curve. $x_2$ is an inferior good and its Engel curve will slope downward. It is impossible for all of the Engel curves to slope downward since more is preferred to less; an increase in income must be spent on at least one good.
Example: \( X_1 \) = health care, \( X_2 \) = hamburger, cereal, milk, margarine, used cars, cheap apartments, Keystone beer, or Timex watches. There is evidence that these latter goods may be inferior, while people generally spend more on health care as their income goes up.

### 4.6.4 Price: the case of substitutes.

A decrease in \( p_1 \) below will cause \( x_1 \) to increase if the law of demand holds. As \( p_1 \) continues to fall we can trace out all of the tangency points, A through B. The resulting curve of such tangency points is known as the **price consumption curve** because price is changing and that is causing a change in the consumption pattern. It is depicted in the diagram on the left below. As \( p_1 \) falls, more \( x_1 \) is consumed. If \( x_1 \) and \( x_2 \) are substitutes, less \( x_2 \) will be consumed as \( p_1 \) falls, \( \text{corr}(x_2, p_1) > 0 \). The consumer is substituting \( x_1 \) for \( x_2 \). Points A and B match up in the diagrams below. Note that \( x_1 \) and \( x_2 \) move in the opposite direction when \( p_1 \) changes when \( x_1 \) and \( x_2 \) are substitutes.

Now you can see where the traditional demand curve comes from. Start at point A in the diagram on the left. When the price \( p_1 \) falls, the budget line swivels out and we pick up a new tangency point between an indifference curve (not depicted) and the new budget line, a point like B. This new tangency point B matches up with a new point on the demand curve, point B in the top diagram on the right. The price \( p_1 \) is lower and the quantity demanded of \( x_1 \) is higher. If we continue lowering the price of \( x_1 \) we can map out additional tangency points in the first diagram. Each one matches up with a point on the demand curve depicted on the right. If the law of demand holds, then we will observe the consumer buying more \( x_1 \) as its price falls. We can also map out a cross price effect between \( p_1 \) and \( x_2 \) in the first diagram that matches up with the lower diagram on the right. As we move from point A to B in the diagram on the left, \( p_1 \) is falling and \( x_2 \) is also falling so the curve on the lower right hand side is upward sloping. If the
two goods are substitutes, then $x_2$ will fall as $p_1$ falls and the "cross price" curve in the lower right diagram will be upward sloping as depicted.

Example: $X_1 = $ movies, $X_2 = $ videos.
Example: $X_1 = $ coffee, $X_2 = $ tea.

4.6.5 Price: the case of complements.
In the case of complements, a decrease in $p_1$ causes $x_1$ to increase under the law of demand but it also causes $x_2$ to increase. Note that $x_1$ and $x_2$ move in the same direction in the case of complements when $p_1$ changes. Once again, start at point A in the diagram on the left and lower $p_1$. Quantity demanded of $x_1$ increases as a result of the law of demand and in the case of complements, $x_2$ also increases. So the traditional demand curve is again downward sloping and the "cross price" curve is also downward sloping.

Example: $X_1 = $ television set, $X_2 = $ cable tv

Example: $X_1 = $ ketchup, $X_2 = $ french fries.

At this point it is useful to dispel some confusion that may arise between two goods being price complements and two goods being complements in the consumer's utility function. When two goods are "price complements," the quantity demanded of the two goods moves in the same way when one of their prices changes. This does not involve the physical attributes of the two goods. If the price of sugar goes up and you buy less coffee and less sugar, then coffee and sugar are "price complements" and the price consumption curve will slope downwards. Sometimes this is stated as the two goods being "complements." And in this case the two goods are physically related. However, it is possible that two goods may not be physically related and still be "price complements." If the price of coffee goes up and you buy less coffee and eat fewer bagels, the two goods are price complements even though they are not necessarily physically related, i.e., you can drink coffee without eating a bagel, and vice versa.

4.7 Data on Consumer Expenditures in the US
NPR reported the following comparison in 2012 from the Consumer Expenditure Survey at the BLS (Bureau of Labor Statistics). The middle class is income between $50,000 and $69,999. The rich are those making more than $150,000. The biggest differences are in education, utilities, savings, and health care. Surprisingly, the rich tend to spend about the average amount on housing, clothes, restaurants, and entertainment.
Are the Rich Different Than the Rest of US?

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Source: http://www.npr.org/blogs/money/2012/08/01/157664524/how-the-poor-the-middle-class-and-the-rich-spend-their-money

4.8 Advertising

Much is made of the possibility of influencing the consumer's choices through advertising and huge amounts of money are spent in the effort. And, many large companies try to compete in a variety of countries and language differences can sometimes lead to hilarious results. The following are the nominees for the recent Chevy Nova Award. This is given out in honor of GM's fiasco in trying to market the Nova in Central and South America. "No va" means, "it doesn't go" in Spanish. Other examples include the following.

1. The Dairy Association's huge success with the campaign "Got Milk?" prompted them to expand advertising to Mexico. It was soon brought to their attention the Spanish translation read "Are you lactating?"

2. Coors put its slogan, "Turn It Loose," into Spanish, where it was read as "Suffer From Diarrhea."

3. Scandinavian vacuum manufacturer Electrolux used the following in an American campaign: "Nothing sucks like an Electrolux."

4. Clairol introduced the "Mist Stick," a curling iron, into Germany only to find out that "mist" is slang for manure. Not too many people had use for a "Manure Stick."

5. When Gerber started selling baby food in Africa, they used the same packaging as in the US, with the smiling baby on the label. Later they learned that in Africa, companies routinely put pictures on the labels of what's inside, since many people can't read. Sales were not impressive. Thank goodness.

6. Colgate introduced a toothpaste in France called Cue. Unbeknownst to Colgate, it was later discovered that Cue is the name of a notorious French porno magazine.

7. An American T-shirt maker in Miami printed shirts for the Spanish market which promoted the Pope's visit. Instead of "I saw the Pope" (el Papa), the shirts read "I Saw the Potato" (la papa). This made the people in Idaho very happy.

8. Pepsi's "Come Alive With the Pepsi Generation" translated into "Pepsi Brings Your Ancestors Back From the Grave" in Chinese, which would be quite a notable achievement if true.

9. The Coca-Cola name in China was first read as "Kekoukela", meaning "Bite the wax tadpole" or "female horse stuffed with wax", depending on the dialect. Coke then researched
40,000 characters to find a phonetic equivalent "kokou kole", translating into "happiness in the mouth." I have absolutely nothing else to add to that.

10. Frank Perdue's chicken slogan in the US market, "It takes a strong man to make a tender chicken" was translated into Spanish as, "It takes an aroused man to make a chicken affectionate." One can, of course, also wonder why it takes a strong man to make a tender chicken in the US. I wonder if there was an Electrolux involved.

You cannot make this stuff up. I dare you to even try.

4.9 Anomalies and Unusual Effects: Thorstein Veblen
In his book, "The Theory of the Leisure Class," Veblen described society as developing and passing through several stages: 1. barbarian phase - everyone is engaged in the production of food and other necessities; 2. pre-industrial - agrarian economy with some inventions, e.g., wheel, cart, ox used in agriculture; 3. industrial state - most production is manufactured. At each step the forces of progress clash with the vested interests epitomized by the leisure class. Progress is slowed down by this clash. Most of society lives at a subsistence level, while a small, wealthy class rules. This is an example of a very uneven income distribution. Karl Marx would have predicted revolution would occur. Veblen invented the phrase "conspicuous consumption" to describe the palaces being built by the wealthy in America circa 1900, stage 3. He described several unusual consumption phenomena including conspicuous consumption, judging quality by price, and trends and bandwagon effects

4.9.1 Conspicuous consumption.
This involves flaunting one's consumption of expensive goods for status purposes. Utility depends on the usual goods and status. Status might be produced by a particular commodity, e.g., sports car, large house, or one’s expensive neighborhood, of one’s total consumption.

Example: Russian caviar. The annual harvest is about 2000 tons, yet only 150 - 200 tons are exported. For a long time one company had the almost exclusive right to export, the Petrossian Co. The price charged in Russia is $5/oz and about $500/oz in NYC.

Example: A luxury dining store in LA sells silver cutlery for $1799 per place setting. It is considered gauche not to buy an even dozen place settings.

Example: The average house built in the 1990s and 2000s is about 25% larger than the average house built in the 1960s and 1970s even though average family size has fallen.

4.9.2 The Veblen effect: judging quality by price.
This occurs when a consumer believes that a higher price means the good is higher quality and thus more desirable. Some would be tempted to conclude that demand slopes upward, i.e., people appear to buy more when the price of the good is high than when it is low. Does it? No. The demand curve is drawn holding everything but price constant, including quality. What is really going on is that there are two different commodities, a low quality brand and a high quality brand, and some people are jumping between the two markets as the price rises.

Example: Inferring the quality of a wine from the price.
4.9.3 **Trends and bandwagons.**
Demand doesn't just depend on the usefulness of the good, but also on who else is consuming it. If a rock star consumes a certain good, for example, people who wish to emulate the rock star will also consume the good. For example, when it became known that Jimmy Page, guitar wizard of Led Zeppelin in the 1970's, liked to drink Jack Daniels, sales of Jack Daniels skyrocketed. This is known as a trend or bandwagon effect; everyone wants to "jump on the bandwagon" and be part of the "cool" crowd. So for some consumers, price is of secondary importance for some goods and other considerations like who is consuming the good are more important.

In the diagram below, notice that the demand is further away from the origin and is more steeply sloped when it contains the bandwagon effect than when it does not. It is further away from the origin because the good is simply more desirable at every price under the bandwagon effect. Also, it is steeper than the normal demand curve because price matters less in determining demand when a bandwagon effect exists; an increase in price reduces demand much less when there is a bandwagon effect working than when there is not.

![Demand Diagram](image)

Other examples: $900 blue jeans, body piercing, latest smart phone.

4.10 **Example: housing**
The demand for single family residential housing provides a good example of consumer theory and how consumers respond to the incentives they face. We can reinterpret our abstract $x_1$-$x_2$ model and derive the demand for housing. We can apply the model to government housing policy. Many governments subsidize housing in a variety of ways. We can use our model of housing to study the impact of policy on the housing market.

Suppose there are two goods housing and general consumption. Preferences are given by $U(h, c)$ where $h$ is housing and $c$ is general consumption. The variable $h$ plays the role of $x_1$ while $c$ plays the role of $x_2$. This allows us to put $h$ on the horizontal axis and $c$ on the vertical axis. The family’s budget constraint is $I = ph + c$, where $I$ is income, $p_1$ is given by $p$, the price of a unit of housing, an abstract concept, and $p_2$ is the price of consumption, which we will assume is equal to one, for simplicity. The graph of the income constraint is in the first pane of the figure. The intercepts are $I/p_1 = I/p$ and $I/p_2 = I/1 = I$. The slope of the budget line is $-p_1/p_2 = -p/1 = -p$. The indifference curves are depicted in the center pane and have the usual properties; the indifference curves are downward sloping and more is preferred to less.
The family chooses housing and general consumption to maximize family welfare or utility subject to its constraint. The result is point a in the right pane. This is where \( \frac{MU_h}{MU_c} = \frac{p}{1} \), or \( MU_h = MU_c \) Housing and general consumption are chosen so the marginal benefit to cost ratio is equal across the two goods.

The budget line shifts out in a parallel way as income increases and we observe new tangency points a - b - c, as in the left hand pane. We can graph these points in consumption - income space as in the right pane. This is the Engel curve. Empirical data strongly suggests that housing and consumption are normal goods so the Engel curve for both goods is upward sloping.

Another interpretation of the model is that we can have data on a **cross section of people earning different levels of income** at a moment in time and observe their housing expenditure. We also tend to notice that wealthier people tend to buy more housing than poor people. So in the last figure, a rich person would be at point c while a poor person would be at point a.

Let's examine a tax subsidy in detail. Suppose \( T \) is the tax collected from the individual and \( T = tB \), where \( t \) is the individual's tax rate and \( B \) is the tax base. Under an income tax the base is income, \( B = I \). Without a write off, the constraint is \( I - T = ph + c \), or \( I - tl = ph + c \), or, finally, \( (1 - t)I = ph + c \). So, in this set up, the tax reduces disposable income from \( I \) to \( I - tl \). This is like a decrease in income and the budget line shifts in in a parallel way; the slope does not change. What happens when there is a write off? Suppose the base is given by \( B = I - aph \), where \( a \) is a percent write off rate, e.g., \( a = 0.2 \). After a couple of steps we have,

\[
I - tl + taph = ph + c.
\]

---

6 Substitute into the budget constraint,
\[ I - tB = ph + c, \]
\[ I - t(I - aph) = ph + c, \]
One interpretation of the write off is that it is like income to the taxpayer since \( taph \) adds to income on the left hand side of the constraint.

Next, subtract the term \( taph \) from both sides of the constraint to get

\[
I - tl = ph - taph + c,
\]

\[
I - tl = (1 - ta)ph + c.
\]

Under this interpretation the "price" of housing is \((1 - ta)p\). Note the product \( ta \) is a fraction less than one. For example, if \( t = .5 \) and \( a = .2 \), then \( ta = .1 < 1 \). The write off reduces the price of housing from \( p \) to \((1 - ta)p < p\) and thus swivels the budget line out just like a reduction in the price of \( x_1 \). The subsidy is greater the higher the write off rate \( a \), the higher the tax rate \( t \), and the more expensive the house, i.e., the higher \( ph \) is. Wealthy individuals receive a larger subsidy than poor individuals for several reasons. Wealthier taxpayers are in a higher tax bracket and wealthier individuals buy more expensive homes.

Note that our model predicts that if homeowners respond to the incentive they face, then the demand for housing will increase. There is much evidence that the houses being constructed in the 1990s and 2000s are much larger than the houses built in the 1960s and 1970s, even though average family size has fallen in the last thirty years. And, just as before, given the price subsidy, it would not be unusual to observe people receiving the subsidy to spend some of the extra income freed up by the subsidy on other commodities. In this model they might increase spending on general consumption \( c \).

### 4.11 Wacky things on the consumption side

NPR reported recently that the company that makes Pringles, the pseudo potato chip, is suing England. Why? In England food is not taxed. However, England does impose a tax on Pringles. Understandably, this upset the maker of Pringles who brought a lawsuit. What is the reason Pringles are taxed, you might ask? England argues that Pringles are not real food and, therefore, can be taxed. This should give one pause before buying Pringles if the suit fails.

NPR also recently reported that a woman is suing the company that makes Cap'n Crunch Crunchberries breakfast cereal. Why? She discovered that what she thought were the crunchberries in the cereal were not real berries hence the lawsuit. How did she determine this, you might ask? She planted some Crunchberries in her garden and they did not grow. Maybe she forgot to water them. Of course, one could also wonder why anyone would have thought that a crunchberry is a real berry anyway since they are hard and, well, crunchy like the rest of the cereal in the box. It is almost needless to say that the lawsuit was dropped.

On a personal note, I am wondering if she is going to sue the company when she discovers the Cap'n depicted on the box is not a real captain, nor is he a real person.

### Appendix

To derive the formula: \( MRS = - \frac{\Delta x_2}{\Delta x_1} = \frac{MU_1}{MU_2} \), note that utility \( u \) depends on the goods you consume according to \( u = U(x_1, x_2) \). A change in utility can only come about through a change in the consumption of \( x_1 \) or \( x_2 \) according to

\[
\Delta u = (\Delta U/\Delta x_1)\Delta x_1 + (\Delta U/\Delta x_2)\Delta x_2.
\]

However, the marginal utilities are defined as \( MU_1 = (\Delta U/\Delta x_1) \) and \( MU_2 = (\Delta U/\Delta x_2) \) so we have instead, \( \Delta u = MU_1\Delta x_1 + MU_2\Delta x_2 \). Along an indifference curve utility is constant and does not change so \( \Delta u = 0 \) along an indifference curve. Hence, \( 0 = MU_1\Delta x_1 + MU_2\Delta x_2 \), from the last equation. Solve this equation to obtain,
\[ 0 = \text{MU}_1 \Delta x_1 + \text{MU}_2 \Delta x_2 \]
\[ \text{MU}_2 \Delta x_2 / \Delta x_1 = - \text{MU}_1, \]
\[ \Delta x_2 / \Delta x_1 = - \text{MU}_1 / \text{MU}_2. \]

Formally, this is the slope of an indifference curve. The MRS is minus the slope of the indifference curve.

### Important Concepts

Preferences
- utility
- indifference curves
- indifference map

Marginal utility
Marginal rate of substitution (MRS)

Income constraint
- prices
- income

Marginal rate of transformation (MRT)

Shifts of the budget line

Optimizing rule: \( \text{MU}_1 / p_1 = \text{MU}_2 / p_2 \)

Consumer responses
- change in tastes
- change in income
- change in price

Unusual effects
- conspicuous consumption
- judging quality by price
- trends and bandwagon effects

Housing and taxes

### Review Questions

1. Why is it typically the case that an indifference curve is downward sloping? What does this reflect? Why do indifference curves further away from the origin reflect a higher value of utility than indifference curves close to the origin?
2. What is the definition of marginal utility? What does it mean when the marginal utility is decreasing?
3. Why does the budget line limit the consumer's choices?
4. How does the budget line shift when there is an increase in income? a decrease in income? a decrease in one of the prices? an increase in a price?
5. What is the ratio \( \text{MU} / P \) for some good? How does the optimizing rule of the consumer match up with the diagram of an indifference curve and budget line?
6. What is the income consumption curve? What is the price consumption curve?
7. Describe the effects discussed by Veblen.
8. How is housing and consumer demand affected by tax policy?
Practice Questions

1. Demonstrate how an increase in income can lead to an increase in the demand for one good but not the other in the diagram provided.

2. The income consumption curve maps out the relationship between
   a. consumption and income
   b. advertising and income.
   c. consumption and advertising.
   d. price and consumption.
   e. income and price.

3. The price consumption curve maps out the relationship between
   a. consumption and income
   b. advertising and income.
   c. consumption and advertising.
   d. price and consumption.
   e. income and price.

4. Can all goods be inferior?
   a. Yes, because more is preferred to less.
   b. No, because more is preferred to less.
   c. No, because the consumer understands there are tradeoffs between goods.
   d. Yes, because the consumer understands there are tradeoffs between goods.

5. Suppose $E_{DI} = 1.2$ for CD's and $E_{DI} = -0.20$ for laundry detergent. Trace out the income consumption curve that reflects this information.
Answers
1. Consider the move from A to B in the diagram,

2. a.
3. d.
4. b.
5. As income increases the budget line shifts out and we trace out the income consumption path or curve. If demand for CD's increases with income but demand for laundry detergent falls, the income - consumption curve is downward sloping as in the diagram.