The Law of Demand:
People do less of what they want to do as the cost of doing it rises.

The cost of an activity, good, or service involves not just monetary costs, but nonmonetary costs as well.

Example 9.1. "Free" Häagen-Däs ice cream.
To help celebrate the re-opening of Beebe Lake, the local Häagen-Däs supplier set up a booth next to the lake and offered free ice cream.
Who was pleased about this offer?
Who was displeased?

"Needs" vs. "Wants"
"Californians don't have nearly as much water as they need."
vs.
"Californians don't have nearly as much water as they want when the price of water is very low."
- Rice farming in the Sacramento valley
- Lush landscaping in San Diego vs. sparse landscaping in Santa Fe

The Rational Utility Maximizer

<table>
<thead>
<tr>
<th>Pepsi Consumption (cans/wk)</th>
<th>Utility from Pepsi consumption (utils/wk)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>15</td>
</tr>
<tr>
<td>3</td>
<td>19</td>
</tr>
<tr>
<td>4</td>
<td>22</td>
</tr>
<tr>
<td>5</td>
<td>24</td>
</tr>
<tr>
<td>6</td>
<td>25</td>
</tr>
</tbody>
</table>

1. Utility increases with consumption
2. Beyond some point, the additional utility from extra consumption declines.

Definition. The **marginal utility** from consuming a good is the additional utility that results from consuming an additional unit of the good.

Definition. The **law of diminishing marginal utility** says that as consumption of a good increases beyond some point, the additional utility that results from an additional unit of the good declines.

Exceptions to the law of diminishing marginal utility:
- The unfamiliar food or melody.
Example 9.2. How many ostrich burgers should Tom consume each week and how many mango milkshakes?
Tom derives all of his nourishment from only two foods: ostrich burgers and mango milkshakes. His utility from consuming each depends on the amount he consumes in the manner shown in the table below. Ostrich burgers cost $8 per pound and mango milkshakes cost $4 per pint. If Tom has $20 per week to spend on food, what combination of the two should he eat?

<table>
<thead>
<tr>
<th>burgers (lb./wk)</th>
<th>Utils/wk from burgers</th>
<th>Shakes (pints/wk)</th>
<th>Utils/wk from shakes</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>.5</td>
<td>10</td>
<td>1</td>
<td>20</td>
</tr>
<tr>
<td>1</td>
<td>16</td>
<td>2</td>
<td>30</td>
</tr>
<tr>
<td>1.5</td>
<td>20</td>
<td>3</td>
<td>32</td>
</tr>
<tr>
<td>2</td>
<td>22</td>
<td>4</td>
<td>33</td>
</tr>
<tr>
<td>2.5</td>
<td>23</td>
<td>5</td>
<td>33</td>
</tr>
</tbody>
</table>

**Method 1.** First list all the combinations of burgers and shakes that cost $20/wk, and then see which one delivers the highest total utility.

<table>
<thead>
<tr>
<th>Combinations of burgers and shakes that cost $20 per week</th>
<th>Total Utility</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.5 lb. of burger, 0 pint of milkshake</td>
<td>23 + 0=23</td>
</tr>
<tr>
<td>2 lb. of burger, 1 pint of milkshake</td>
<td>22 + 20=42</td>
</tr>
<tr>
<td>1.5 lb. of burger, 2 pint of milkshake</td>
<td>20 + 30=50</td>
</tr>
<tr>
<td>1 lb. of burger, 3 pint of milkshake</td>
<td>16 + 32=48</td>
</tr>
<tr>
<td>.5 lb. of burger, 4 pint of milkshake</td>
<td>10 + 33=43</td>
</tr>
<tr>
<td>0 lb. of burger, 5 pint of milkshake</td>
<td>0 + 33=33</td>
</tr>
</tbody>
</table>

Tom’s optimal combination is to consume 1.5 pounds of ostrich burger each week and 2 pints of mango milkshake. His total utility from this combination is 50 utils per week, more than he could have gotten from any of the other possible combinations.

**Definition:** The **optimal combination of goods** is that combination that yields the highest total utility among all the affordable combinations.

**Method 2.**
To achieve the highest possible utility from a given expenditure, divide your purchases among goods so that the marginal utility of the last dollar spent on each good is as large as possible.
If Tom directs his next purchase toward the category with the highest MU/$, he will end up consuming 1.5 pounds per week of ostrich burger and 2 pints of mango milkshake.

When the quantity of each good can be varied continuously, we have:

**The Rational Spending Rule:**

> Spending should be allocated across goods so that the marginal utility per dollar is the same for each good.

**Example 9.3. Is Sue maximizing her utility from consuming cashews and pistachios?**

Cashew nuts sell for $8 per pound and pistachios sell for $4 per pound. Sue has a budget of $800 per year to spend on nuts, and her marginal utility from consuming each type of nut varies with the amount consumed as shown in below. If she is currently buying 80 pounds of cashews and 40 pounds of pistachios each year, is she maximizing her utility?

<table>
<thead>
<tr>
<th>Marginal utility of cashews (utils/lb)</th>
<th>Marginal utility of pistachios (utils/lb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>16</td>
</tr>
<tr>
<td>80 lb/yr</td>
<td>40 lb/yr</td>
</tr>
</tbody>
</table>

With 80 pounds per year of cashews and 40 pounds of pistachios, Sue is spending her entire $800 annual budget for nuts. But because her marginal utility from pistachios is 16 utils per pound, and because pistachios cost $4 per pound, her current spending on pistachios is yielding additional utility at the rate of (16 utils/pound)/(4 utils/pound) = 4 utils per dollar.

By the same token, because Sue’s marginal utility for cashews is 20 utils per pound and because cashews cost $8 per pound, her current spending on cashews is yielding only (20 utils/pound)/(8 utils/pound) = 2.5 utils per dollar.

Thus, her current spending yields higher marginal utility per dollar for pistachios than for cashews. And this means that Sue cannot possibly be maximizing her total utility.

To see why, note that if she spent $8 less on cashews (one pound less than before), she would lose about 20 utils\(^1\); but with the same $8, she could buy two additional pounds of pistachios, which would boost her utility by about 32 utils\(^2\), for a net gain of about 12 utils. Under Sue’s current budget allocation, she is thus spending too little on pistachios and too much on cashews.

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\(^1\) The actual reduction would be slightly larger than 16 utils, because her marginal utility of cashews rises slightly as she consumes less of them.

\(^2\) The actual increase will be slightly smaller than 24 utils, because her marginal utility of pistachios falls slightly as she buys more of them.
In the next example, we investigate what happens if Sue spends $16 per year less on cashews and $16 per year more on pistachios.

**Example 9.4. Is Sue maximizing her utility from consuming cashews and pistachios (II)?**

Sue’s total nut budget and the prices of the two types are the same as in Example 9.3. If her marginal utility from consuming each type varies with the amount consumed as shown below and if she is currently buying 70 pounds of cashews and 60 pounds of pistachios each year, is she maximizing her utility?

When Sue increases her consumption of pistachios, her marginal utility of pistachios falls. Conversely, when she reduces her consumption of cashews, her marginal utility of cashews rises.

Note first that the direction of Sue’s rearrangement of her spending makes sense in light of Example 9.3, in which we saw that she was spending too much on cashews and too little on pistachios. Spending $16 less on cashews causes her marginal utility from cashews to rise from 20 to 28 utils per pound. Spending $16 more on pistachios causes her marginal utility from pistachios to fall from 16 to 8 utils per pound. Both movements are a simple consequence of the law of diminishing marginal utility.

Since cashews still cost $8 per pound, her spending on cashews now yields additional utility at the rate of 

\[
\frac{28 \text{ utils/pound}}{8 \text{ dollars/pound}} = 3.5 \text{ utils per dollar.}
\]

Similarly, since pistachios still costs $4 per pound, her spending on pistachios now yields additional utility at the rate of only 

\[
\frac{8 \text{ utils/pound}}{4 \text{ dollars/pound}} = 2 \text{ utils per dollar.}
\]

So at her new rates of consumption of the two types of nuts, her spending yields higher marginal utility per dollar for cashews than for pistachios—precisely the opposite of the ordering we saw in Example 9.3.

Sue has thus made too big an adjustment in her effort to remedy her original consumption imbalance.

**Example 9.5. Is Sue maximizing her utility from consuming cashews and pistachios (III)?**

Sue’s total nut budget and the prices of the two flavors are again as in Examples 9.3 and 9.4. If her marginal utility from consuming each type varies with the amounts consumed as shown below and if she is currently buying 50 pounds of pistachios each year and 75 pounds of cashews each year, is she maximizing her utility?

This time Sue has it just right. At her current consumption levels, marginal utility per dollar is exactly 3 utils per dollar for each type of nut.

**The Rational Spending Rule**

The Rational Spending Rule can be expressed in the form of a simple formula. If we use \(MU_C\) to denote marginal utility from cashew consumption (again measured in utils per pound), and \(P_C\) to denote the price of cashews (measured in dollars per pound), then the ratio \(MU_C/P_C\) will represent the marginal utility per dollar spent on cashews, measured in utils per dollar. Similarly, if we use \(MU_P\) to denote the marginal utility from pistachio
consumption, and $P_p$ to denote the price of pistachios, then $MU_p/P_p$ will represent the marginal utility per dollar spent on pistachios.

The marginal utility per dollar will be exactly the same for the two types—and hence total utility will be maximized—when the following simple equation is satisfied:

**The Rational Spending Rule for two goods:**

$$\frac{MU_C}{P_C} = \frac{MU_p}{P_p} .$$

The rational spending rule is easily generalized to apply to spending decisions regarding large numbers of goods. In its most general form, it says that the ratio of marginal utility to price must be the same for each good the consumer buys. If the ratio were higher for one good than for another, the consumer could always increase her total utility by buying more of the first good and less of the second.

**The Rational Spending Rule for two goods, X and Y:**

$$\frac{MU_X}{P_X} = \frac{MU_Y}{P_Y} .$$

Suppose $MU_X/P_X > MU_Y/P_Y$. Then you can increase total utility by spending a dollar less on Y and a dollar more on X.

Suppose $MU_X/P_X = 3 > MU_Y/P_Y = 2$.

Then by spending a dollar less on Y (lose 2 utils) and a dollar more on X (gain 3 utils) you can achieve a net gain of 1 util for the same expenditure.

**The Rational Spending Rule for N goods:**

$$\frac{MU_1}{P_1} = \frac{MU_2}{P_2} = ... = \frac{MU_N}{P_N} .$$