# Chapter 2

## Building blocks for consumer theory

The purpose of this chapter is to develop a framework for thinking about consumers and their choices. It is important to begin with a description of the physical environment that exists in the economy.

**The Physical environment**

In this case, we need only one period. If you want to be concrete, think of it as one week. During this week, the consumer is paid in dollars at the beginning of the week. Let $y$ represent the size of this income. The consumer chooses between two perishable consumer goods, labeled $f$ and $a$, for fish and apples, respectively.[1]

There is a large number of producers and a large number of consumers. Not one person can affect the market.

Trade exists. There are anonymous fish producers and apple producers that exist in the economy. Each sells a homogeneous product; that is, the fish are identical from one producer to the other. Similarly, apples are identical. The point is that one consumer does not care about any one individual producer.

**The consumer's budget constraint**

Overall, two things matter. First, each producer is offering an identical product. Second, there is no cost to going from one producer to another. It is costless for a consumer to travel from one producer to the next. Thus, producers will sell their item to a consumer at the going price. Let $p_f$ be the price for one fish and $p_a$ be the price of an apple. To be more explicit, $p_f$ is the number of dollars exchanged for one fish and $p_a$ is the number of dollars exchanged for one apple. Thus, the dollar expenditure on fish is the product $p_f \times f$ and the dollar expenditure on apples is $p_a \times a$, where $f$ is the number of fish (including any fractions of fish) purchased and $a$ is the number of apples purchased.

As we did in the trade chapter, let the price of fish be used as the numeraire. Consumers cannot borrow, so their expenditures are captured by

$$y = p_f \times f + p_a \times a$$

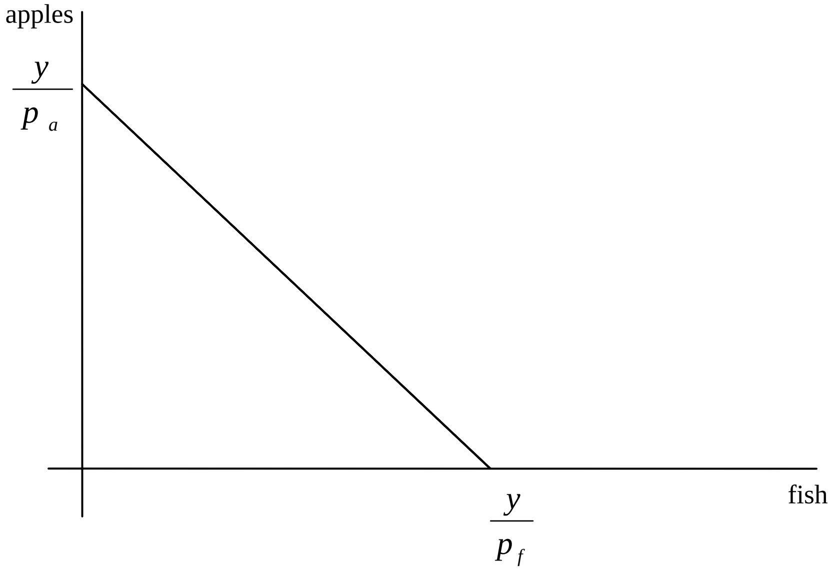
In other words, consumers will take the income that they have at the beginning of the week and spend it on fish and apples. By designating fish as the numeraire, we define income, measured in dollars originally to be measured in units of fish. Divide both sides of equation (1) by $p_f$, yielding

$$\frac{y}{p_f} = f + \frac{p_a}{p_f} \times a \qquad (2)$$

So, the left-hand-side of equation (2) tells us how much income we have measured in units of fish. In other words, we have changed our unit of measure from dollars to quantity of fish. For example, if one's income is $1000 and the price if $2 per fish, the left hand side of equation (2) is stated in terms of income measured in units of fish, which is 500 fish. The right-hand-side of equation (2) also has to be measured in units of fish. Clearly, the first term, *f*, is the number of fish purchased by the consumer. The second term, $\frac{p_a}{p_f} \times a$, is the quantity of apples measures in units of fish.[2] In other words, the second term measures the quantity of apples purchased by the consumer in terms of their value in units of fish.

Equation (2) is the basis for our analysis. It is called the budget constraint. I can graph this equation with the quantity of fish on the horizontal axis and the quantity of apples on the vertical axis. Figure 2.1 represents the budget constraint.

**Figure 2.1**




Now, suppose that this person spent their entire income on fish. The maximum quantity of fish she could acquire is $\frac{y}{p_f}$ fish. If, however, she spent her entire income on apples, she could acquire $\frac{y}{p_a}$ apples. Every point on the budget constraint tells us a combination of fish and apples that this consumer can afford to purchase in the case in which the consumer exhausts her budget. That is, there is no money is left over after fish and apples are purchased.[3]

It is straightforward to deduce the slope of the budget line. We have two points on a straightline, the vertical and horizontal intercepts. Let the vertical intercept be the first point and the horizontal intercept be the second point. Then, $\frac{\Delta a}{\Delta f} = \frac{y/p_a - 0}{0 - y/p_f}$, which can be rewritten as $-\frac{y/p_a}{y/p_f} = -[y/p_a \div y/p_f] = -\frac{p_f}{p_a}$. Thus, the slope of the budget constraint is simply the price of fish relative to the price of apples, or simply the inverse of the relative price when the price of fish is used as the numeraire.

The slope is negative because there is a tradeoff. If I purchase one more fish, I have to give up some apples, or vice versa. The rate at which I give up apples for every fish I gain is given by the relative prices of the two items. So, the geometry of the budget constraint has economic meaning; it tells how many apples I can purchase for every fish that I do not buy.

Overall, the budget constraint is one vital piece of information when trying to understand what consumers actually buy. In the end, it is only piece. It tells us how much the consumer can afford. The two main features of the budget constraint are that the points represent all the combinations of goods that a person can purchase. The second important feature is the slope, which tells us the rate at which we trade one item for another. The slope is fixed because the consumer is a price taker. It is more complicated to study a case in which the person determines the price. For our purposes, there are many consumers so it is reasonable to assume that each one is small relative to the entire set of consumers. This smallness is interpreted as an individual consumer cannot influence the price they pay for an item. Rather, they must accept the price offered to them.

**Changes affecting the budget constraint**

Next, we consider two factors that affect the consumer's budget constraint. First, consider the impact that a change in income will have. Before we begin the more rigorous development of this impact, think about the change for a moment. With more income, you will be able to purchase more products. So, the set of feasible items should be bigger.

Formally, consider a case in which dollar income rises. Let $y_1 > y_0$, where $y_0$ is the original income level and $y_1$ is the new income level. Hold everything else the same. With this change, the consumer's budget constraint changes from $\frac{y_0}{p_f} = f + \frac{p_a}{p_f} \times a$ to $\frac{y_1}{p_f} = f + \frac{p_a}{p_f} \times a$. Graphically, this changes is depicted as

**Figure 2.2**

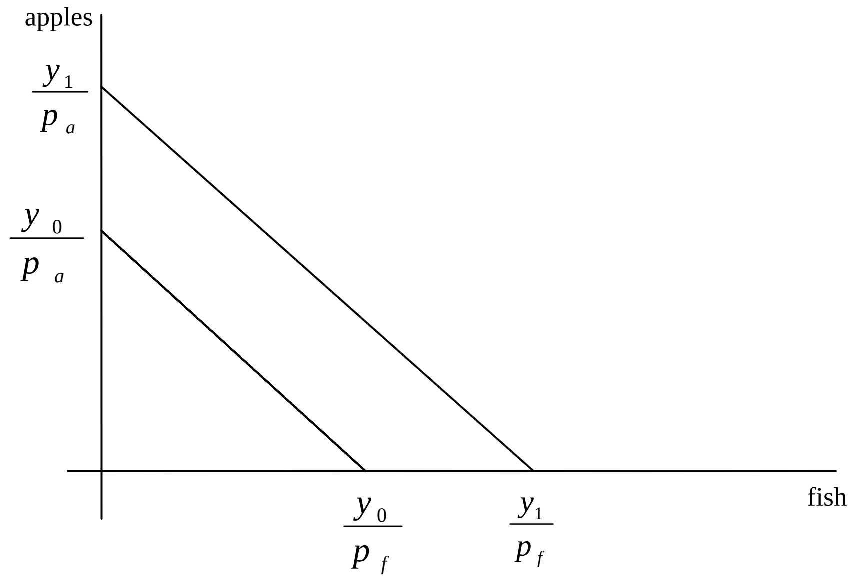


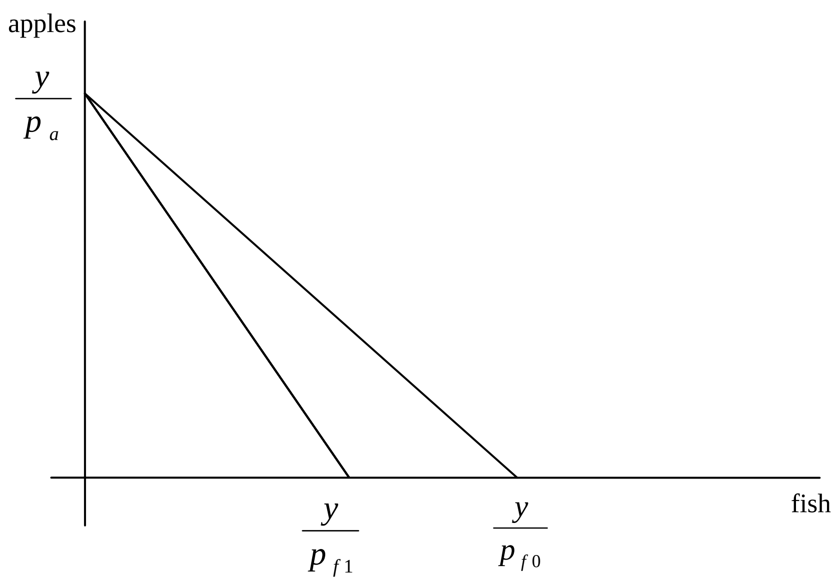

Figure 2.2 shows that the budget constraint shifts to the right when income increases. Visually, this captures the intuition we have; that is, more goods can be purchased with more income. Since all the combinations of apples and fish that you could purchase with income level $y_0$ can be purchased with income level $y_1$. The converse, however, is not true; there are some bundles of fish and apples that you can purchase with income at $y_1$ that you cannot afford with income $y_0$.

The other thing to note is that the shift in the consumer's budget constraint is parallel. Why? Remember I fixed the relative price of fish and apples to be the same in both cases. Since the slope of the budget constraint is minus one times the relative price, by holding relative prices constant, I am assuring that the slope of the budget line will also be the same.

The second thing we can study is the case in which one price changes. Suppose, for example, that the price of fish increases from $p_{f0}$ to $p_{f1}$. In equation form, we change from $\frac{y}{p_{f0}} = f + \frac{p_a}{p_{f0}} \times a$ to $\frac{y}{p_{f1}} = f + \frac{p_a}{p_{f1}} \times a$. This change in the price of fish, holding everything else constant, has two channels through which it affects the budget constraint. First, there is the change in the relative price; fish is more expensive relative to apples under the new price than it was under the old price. Second, real income—dollar income divided by the price of fish—is lower under the new price than under the old price.

Figure 2.3 depicts these two effects graphically. There are two aspects of Figure 2.3 that have economic interpretations. First, there is the income effect. In the context of the graph, the consumer's real income is lower when the price of fish is $p_{f1}$ than when the price of fish is $p_{f0}$. To see this, note that there are some combinations of fish and apples that were affordable when the price of fish is lower, but are no longer affordable when the price of fish increases.

**Figure 2.3**




Second, the budget constraint has a steeper slope when the price of fish is $p_{f1}$ than when the price of fish is $p_{f0}$. This is just another way of saying that when the price of fish increases, for example, that a person can acquire more apples by giving up one fish. Or, put another way, the relative price of fish is higher.

Thus far, we have focused on the budget constraint. This is one of two important pieces that help us understand consumer choices. Indeed, the budget constraint describes the set of items that the consumer can afford. We now turn our attention to describing which item in that set that the consumer will choose. To do so, we will need to characterize our consumer's preferences.

**Preferences**

Preferences are the term that applies to consumer's wants. There are key concepts that permit one to characterize the consumer's behavior when conjoined with the budget constraint.

First, it is useful to introduce the term *bundle*. A bundle is a combination of goods that a consumer is choosing from. In our setting, a bundle is a quantity of fish and a quantity of apples. With this terminology in place, we can move to the next issue, which is comparing these bundles. At the heart of this analysis is the assumption that a consumer can rank any two bundles in terms of which one gives them greater happiness. To illustrate this point let me define a bundle of fish and apples and call this bundle $x_0$. In addition, let me define another bundle of fish and apples and call it $x_1$. I assume that a consumer can assign a number to each bundle representing the happiness that the bundle gives the consumer. If the number for bundle $x_0$ is greater then the number for $x_1$ then we say that bundle $x_0$ is preferred to bundle $x_1$, or in shorthand, $x_0 > x_1$. If, on the other hand, number for bundle $x_0$ is less then the number for $x_1$ then we say that bundle $x_1$ is preferred to bundle $x_0$, or in shorthand, $x_1 > x_0$. Lastly, it is possible that each bundle gives the consumer the same level of happiness. Thus, we say that the consumer is indifferent between bundle $x_0$ and bundle $x_1$, or that $x_1 = x_0$.

Four assumptions are necessary to make progress. First, the ordering of preferences is complete. In our setup, a person can look at any pair of bundles and determine which of the three descriptions holds; that is, I prefer one bundle to the other, or I am indifferent between the two bundles.

Second, more is preferred to less. Suppose there are two bundles that have exactly the same quantity of fish, but one bundle contains more apples than the other. Of these two bundles, I will always prefer the one with more apples. A more precise way of saying the same thing is to say that, holding everything else constant, my happiness number increases, for instance, when I increase the quantity of a good.

Third, happiness increases at a decreasing rate. Consider, again, the case in which I have two bundles that differ only in the number of apples. The happiness, or *utility*, that I derive from each of these bundles is captured by a number. Suppose, for example, that the bundle—call it bundle 0--with the smaller number of apples gives utility equal to 25 and that the bundle with 1 more apple—call it bundle 1--gives utility equal to 50. The implication is that change in utility, also known as the marginal utility, of that one apple is 25. Next, consider a third bundle—call it bundle 2--that is identical to the bundle 1, but has one additional apple. Suppose that the utility in bundle 2 is 62. Now, the marginal utility from bundle 1 to bundle 2 is 12. Moreover, because the marginal utility is diminishing as I add each additional apple, the utility function—the equation that takes apples and fish and converts it to a utility number—exhibits the property that happiness increases at a decreasing rate. This third assumption is also known as diminishing marginal utility.

Fourth, I assume that preferences satisfy the transitive property. So, if I have three bundles, say $x_0, x_1, x_2$. Further, suppose that $x_1 > x_0$. If $x_2 > x_1$, then transitivity implies that $x_2 > x_0$. Transitivity also extends to cases in which I am indifferent between three bundles; that is, if $x_1 = x_0$ and $x_2 = x_1$, then $x_2 = x_0$.

With these assumptions, it is possible to graphically characterize a specific group of bundles. Suppose we want to look at bundles that all have the same utility level. The graph for one such characterization is called an *indifference curve*. Figure 2.4 depicts this graph. Every point on the indifference curve labeled, $U_0$, represents a bundle of apples and fish in which the person gets the same level of utility. In other words, I am indifferent between any two bundles that are on this particular indifference curve.

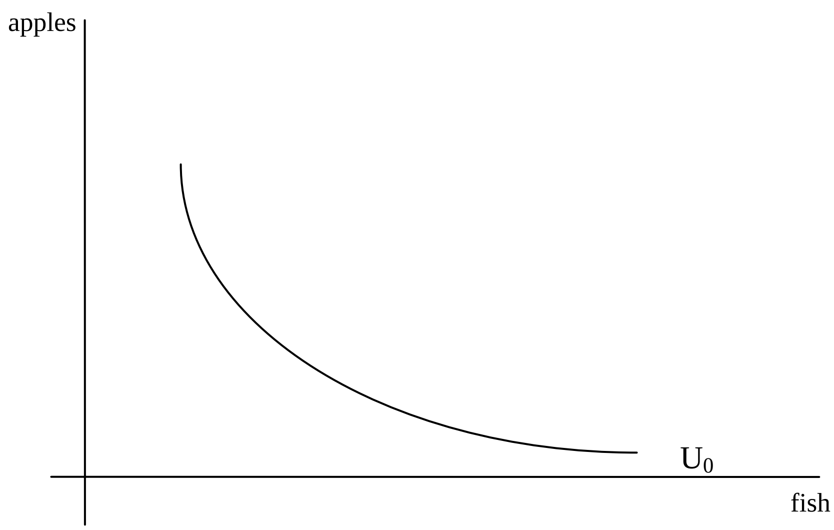
There are two distinctive aspects that need to be examined for Figure 2.4. First, the slope of the curve is negative. This aspect has a very intuitive appeal. Both apples and fish are goods. This means that if you get a little more fish, other things being equal, you will be happier. In other to hold utility constant, one would have to reduce the amount of apples. The indifference curve captures this by exhibiting a negative slope.

Second, the indifference curve is a curve, not a straight line. Indeed, the indifference curve is curved because we assume that there is diminishing marginal utility.

To be more precise, the indifference is convex with respect to the origin (which is where the apples-axis intersects the fish-axis.

To illustrate the economic intuition that goes with a convex shape, consider a bundle that has very few fish. Because fish are rare in this bundle, our consumer gets a lot

**Figure 2.4**

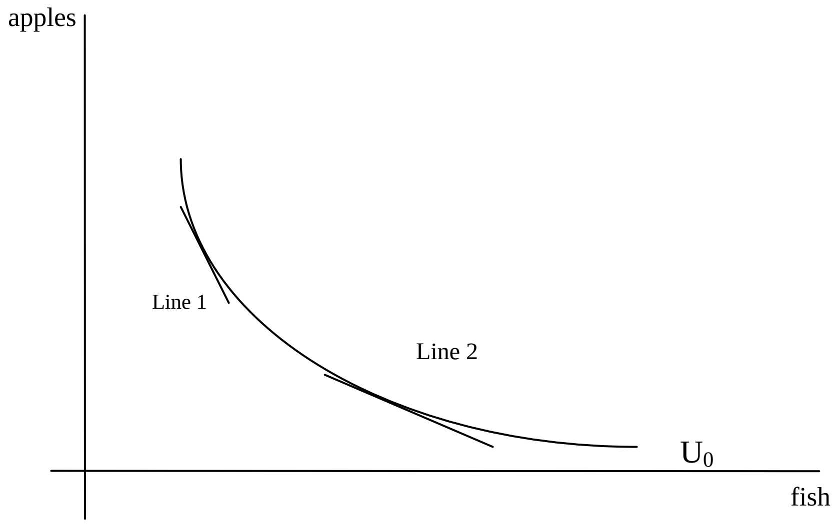



of extra utility from one extra fish. So, if the consumer receives one extra fish, he must give up some apples. In this case the change in the quantity of apples is relatively large in order to keep utility constant. The slope of the indifference curve, also known as the marginal rate of substitution, is a large negative number because the change in apples (the rise) is large relative to the change in fish (the run).

Because the indifference curve has different slopes at different bundles, lets consider a case in which our consumer has lots of fish. With plentiful fish, the utility gain from one extra fish is small, by assumption of diminishing marginal utility. With fewer apples in this initial bundle, a smaller quantity of apples are taken from the bundle to get one extra fish because each apple now is attached to a greater change in utility. In order to keep utility constant, fewer apples are given up to get one extra fish when you start out with lots fish in your bundle.

This example is illustrated in Figure 2.5. The straight lines are tangent to the indifference curve. This means that they measure the slope or the marginal rate of substitution at different points on the indifference curve.  Line 1 corresponds to a bundle

**Figure 2.5**

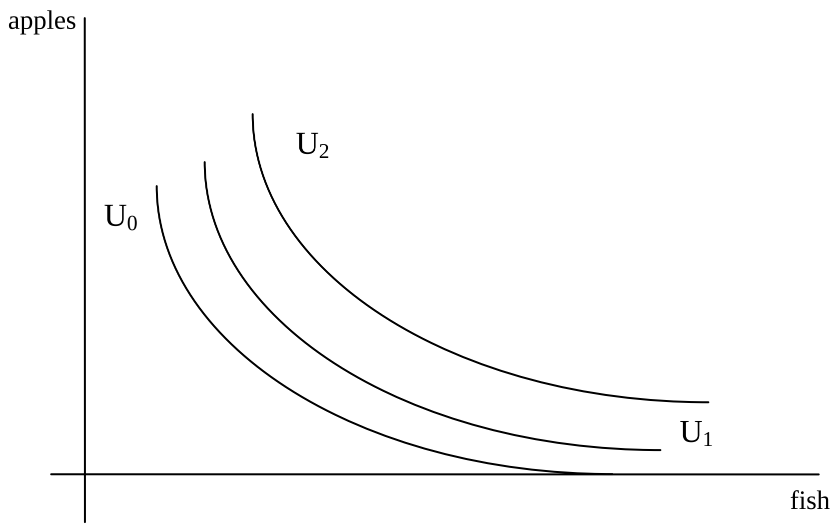



with some quantity of fish and apples. Line 2 corresponds to a bundle with relatively more fish and fewer apples. Note that Line 1 is steeper than line 2. The economics is straightforward: the steeper line indicates that when evaluated at first bundle, a consumer would give up so many apples to obtain a morsel more of fish in order to hold utility constant. However, at the second bundle, the consumer would give up fewer apples to obtain the same morsel of fish. This consumer exhibits diminishing marginal utility, giving up fewer and fewer apples to obtain each additional morsel of fish.

The slope of the indifference curve is given a special name. The *marginal rate of substitution* is the rate at which a consumer is willing give up some of one good in order to obtain a little more of the other good. We can use our setup with only two goods and our knowledge of geometry to make the connection between the marginal rate of substitution and the slope of the indifference curve more concrete. Note that the slope of the curve is defined as rise over run, or, alternatively as the quantity of the good on the vertical axis that the person gives up in order to obtain a little more of the good on the horizontal axis. Given the definition of the marginal rate of substitution, it is straightforward to see that the geometric interpretation of the slope of the indifference curve is the economic concept.

We have developed the shape of the indifference curve by looking at one indifference curve. There is an entire family of indifference curves that exist. Figure 2.6 shows a diagram in which three indifference curves are present. Figure 2.6 is still incomplete because there are billions and billions of indifference curves. There is a valuable lesson. Note that each curve—$U_0$, $U_1$, and $U_2$—represent bundles of apples and fish that yield a particular level of utility. By the assumption that more is preferred to less, we know that happiness associated with indifference curve $U_0$ is less than the happiness level associated with $U_1$, which in turn is less than the happiness level associated with $U_2$. In other words, the farther an indifference curve is from the origin, the greater the utility level it represents.

**Figure 2.6**




There are two key ideas to take away from this framework. First, for a *particular* indifference curve, you know that every bundle on that curve gives the consumer the same utility. The consumer is indifferent between any two bundles that lie on one indifference curve. Second, there literally an infinite number of indifference curves. As one moves farther away from the origin, for example, to the northeast of our graphs, the consumer is comparing more goods to fewer goods. (You could also simply move directly east or directly north and have more of just one of the goods.) Because consumers like more—that is, more is preferred to less—two indifference curves represent two different levels of utility. Indeed, the second key idea is that comparing two indifferences curves, greater utility is associated with the indifference curve that is farther from the origin.

**Summary**

The two most important tools for studying consumer behavior are developed in this chapter. The first tool is the budget constraint. With this tool, we know how much the consumer can afford to purchase. The second tool is the indifference curve. This tool is essential to characterizing what the consumer wants when facing a choice between the too goods present in the economy.

Our next step is to bring the two pieces together. Like a puzzle, we will fit the indifference curve together with the budget constraint. In doing so, it is possible to solve the consumer's choice problem. In other words, we can identify what bundle a consumer will choose when facing a particular pair of prices and with a specified level of income.

In illustrating the consumer's choice problem, we will need to specify a criterion. We will appeal to the notion that the consumer's primary goal is to maximize their utility. With the properties of the indifference curve and the budget constraint developed in this chapter, we will add the maximization criterion, developing the key features that our consumer will satisfy.

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[1] The careful reader will notice that I permitted both fish and apples to have a longer shelf life in this chapter. The length of time will not affect the results obtained.

[2] You can see this by applying some simple algebra. Note that $p_a$ is dollars per apple, or $\frac{\$}{apple}$. Multiply this by number of apples to get $\frac{\$}{apple} \times apple = \$$. Then divide this result by $p_f = \frac{\$}{fish}$, or

$$\frac{p_a}{p_f} \times a = \left[ \frac{\$}{apple} \div \frac{\$}{fish} \right] \times apple = \left[ \frac{\$}{apple} \times \frac{fish}{\$} \times apple \right] = fish$$

[3] In case you want to think about savings, just ignore it for now. We will get to it later. For now, just assume that there is no savings.