NOTE ON CONSUMER SURPLUS

An important concept that we will use when we evaluate the ways in which markets distribute economic value among consumers and firms is consumer surplus. You encountered consumer surplus in your M&S 431 class, where you referred to it as “$B - P$.” We begin by talking about the concept of consumer surplus for discrete goods. We will then discuss how the concept relates to more general demand curves.

DISCRETE GOODS AND RESERVATION PRICES

Some products such as automobiles, houses, personal computers, and major appliances are indivisible, so a consumer must typically buy these products in whole (usually large) units. The demand for such products is called discrete because the quantity demanded jumps up by whole units as the price drops. If an individual demands at most one unit of a good, the quantity demanded is either 1 or zero, and the demand “curve” has the form shown in Figure 1.

The highest price the consumer is willing to pay for the product is called the consumer's reservation price, valuation, or maximum willingness to pay. This maximum willingness to pay represents how much the product is worth to the consumer. In your M&S 431 strategy class, you referred to this maximum willingness to pay as “$B$.”

---

1 ©2002 Nabil Al-Najjar and David Besanko. These notes were adapted from an earlier set of notes prepared by Professor Nabil I. Al-Najjar. These notes are for the exclusive use of MECN 430 classes at the Kellogg School of Management. Do not circulate or copy these notes for any other use without explicit permission of the author. Version of November 10, 2003.

2 Another term used by management consultants for reservation price is “switching price.”
Different consumers typically have different reservation prices for a given product. Market demand is obtained by summing the demands of individual consumers. Consider the demand curves of three consumers, the first with a high reservation value, the second intermediate and the third low.
When we sum the demands of these three, we will get a market demand curve which is smoother than any of the individual demand curves. The reason is that the jumps in individual demand occur at that individual's reservation price. But, if there are many consumers with sufficiently varied reservation prices, market demand will look increasingly like a continuous curve:

![Figure 3](image)

This representation allows us to interpret points on the quantity axis as representing different individual consumers with decreasing valuations for the product. It is useful to refer to the lowest valuation consumer who buys the product at a price $P$ the **marginal consumer** (at the price $P$). With continuous (or nearly continuous) demand, the marginal consumer is the one who values the product just enough to buy it, but not for any more than the amount she is currently paying (the other consumers who buy at that same price $P$ would have been willing to pay a higher price). Another way to think of the marginal consumer is, if we lined up all the consumers by their willingness to pay (which is just what the demand curve does), the marginal consumer is the last one willing to buy at that price; for the firm to get any more customers, it would have to lower its price.

**EXAMPLE: MEASURING MAXIMUM WILLINGNESS TO PAY FOR A PRODUCER GOOD**

Let’s explore another example of maximum willingness-to-pay and how we would estimate it, but now for an intermediate good that is used as an input in the production of a finished product. Consider, for example, a producer of soft drinks that uses corn syrup as a sweetener. What is the maximum amount that a producer would be willing to pay for corn syrup before switching from corn syrup to an alternative sweetener? Suppose that the best available alternative to using corn syrup is to use sugar. Let’s further suppose that as far as the ultimate consumer is concerned, the manufacturer’s choice of sugar or corn syrup is immaterial; the final product ---say a cola --- tastes exactly the same. Given this
is the case, the manufacturer’s maximum willingness-to-pay for corn syrup depends on the cost economics of corn syrup versus the cost economics of sugar.

Figure 4 shows how. The left-hand side of the figure shows the economics of production when the soft-drink producer uses sugar to manufacture cola. In particular, when the cost of sugar is 2 euros per hundred-weight, “all-in” production costs using sugar (sugar costs plus other materials costs plus processing costs plus packaging costs) are 17 euros per hundred-weight of cola produced. The right-hand side shows that by using corn syrup, the producer incurs somewhat higher processing costs and somewhat higher costs of other materials. So what is the most the soft-drink producer would be willing to pay for corn syrup? The figure shows that it would be willing to pay up 2 euro per hundred-weight. This is the price of corn-syrup at which the cola maker’s “all-in” production cost using corn syrup is the same as its costs would be if it used the best available alternative to using corn syrup, namely sugar. If the price of corn syrup were any higher than 2 euro per hundred-weight, the soft drink producer would be better switching to sugar as its sweetener.

By calculating the maximum willingness to pay for corn syrup for different segments of consumers (e.g., soft drink makers, candy makers, producers of ready-to-eat cereal, and so on), we could generate a demand curve for corn syrup in much the same way we generated the demand curve above.

---

3 A hundred-weight is a unit of weight. The numbers used in this example are for illustrative purposes only and are thus not based on the actual production costs of any particular soft drinks producer.

4 For simplicity, we have ignored any switching costs (e.g., costs of reconfiguring processing machinery) that the manufacturer incurs in switching from corn syrup to sugar. Conceptually, a switching cost would add to the cost, from the manufacturer’s perspective, of using sugar and would work to increase the maximum willingness to pay for corn syrup.
CONSUMER SURPLUS

Each time a consumer buys a product, it must be that the product is worth at least as much to him as the amount of money he actually paid for it. If the consumer is not the marginal consumer, the product is actually worth more to him than he paid. This individual got away with some "surplus benefit," equal to his value of the transaction minus all costs incurred. In your M&S 431 strategy class, you referred to this surplus as "B – P."

EXAMPLE: CONSUMER SURPLUS FOR MOVIE GOERS

Suppose that individuals interested in watching a particular movie can be divided into 5 subgroups of equal size, say 100 in each group. Each individual is willing to see the movie at most once. Individuals in group 1 are willing to pay up to $13 to see the movie (so, 12 is their reservation price). Individuals in groups 2 through 5 are willing to pay up to $10, $7, $4, and $1, respectively. Since consumers buy at most one unit, we once again have a market with discrete demand. We represent this by Figure 5:

![Figure 5](image-url)

Suppose that the theater sets a price of $5 per ticket. Individuals with reservation prices above $5 (groups 1, 2, and 3) will see the movie, while consumers in the fourth and fifth groups will not. Since individuals with the highest reservation price ($13) only paid $5, they realize a surplus of $8 each, yielding a total surplus for this group of \((13 - 5) \times 100 = 800\). We can do the same calculation for each of the groups. The total consumer surplus \(CS\) is simply the sum of the individual surpluses:

\[
CS = 100 \times [(13 - 5) + (10 - 5) + (7 - 5)] \\
= 800 + 500 + 200 = 1,500.
\]
This is shown as the shaded area in Figure 6. In this figure, and in general, consumer surplus is measured as the area beneath the demand curve above price.

The consumer surplus of $1,500 represents what consumers would have been willing to pay above and beyond what they actually did pay. In other words, if everyone in groups 1-3 paid their reservation values, they would have paid $3,000. Instead, they paid only $300 \times $5 = $1,500. So, the sum of reservation prices is equal to total expenditures plus total consumer surplus (that is, $1,500 + $1,500 = $3,000).

From the perspective of the theater, consumers are getting away with $1,500 worth of “value” or “surplus.” This is sometimes referred to as “money left on the table.” If the manager of the theater could find a way to extract some of that surplus, the theater's profits would increase at the expense of consumers (which may be good or bad depending on which point of view you take).

**EXAMPLE:**

A phone company charges a monthly fee plus a charge per minute for use of cellular phones. For the demand curve in Figure 7, consumer surplus is the shaded area less the monthly fee. For example, at a price of $0.20/minute and zero monthly fee, the surplus is represented in Figure 7 as the area beneath the demand curve above the price.
If in addition there is a monthly fee of $10/month, then the consumer surplus is the consumer surplus we just calculated minus $10/month = $50/month - $10/month = $40/month. This means that the consumer would pay up to $40/month for the privilege of getting phone service at fixed charge of $10 and an additional charge of $0.20/minute.

General Definition of Consumer Surplus and How We Will Use It

Consumer surplus is the total benefit from the consumption of a product net of the total cost of purchasing it. In the special case where the good is sold freely at a constant market price, consumer surplus is the area above the market price but below the demand curve.

In this course we will use consumer surplus in two ways. First, it is a measure of how much economic value is captured by consumers through their market transactions. Second, we will use it when we analyze pricing decisions by firms that are aimed at converting a portion of this consumer surplus into profit.

The Diamond-Water Paradox

A famous puzzle posed by Adam Smith is the so-called “Diamond-Water Paradox:

---

5 This calculation assumes that the consumer will continue to buy a quantity $Q = 100$ at a price of $0.20$/minute regardless of whether there was a fixed monthly charge for the service. Under what conditions is this a reasonable description of consumers' behavior?
Nothing is more useful than water: but it will purchase scarce anything; scarce anything can be had in exchange for it. A diamond, on the contrary, has scarce any value in use; but a very great quantity of other goods may frequently be had in exchange for it.

--- Adam Smith, Chapter 4, *The Wealth of Nations*, 1776.

Why are people willing to pay more for diamonds than water, even though water is clearly more valuable?

The key to understanding this paradox is the distinction between the total consumer surplus and the surplus of the marginal unit (i.e., the last unit consumed). In the last example, the total surplus realized from the option to buy cellular service at a price of .20 is $50, but the surplus realized from the last unit consumed (unit 100) is about zero. Thus, to the question “Which would you rather give up, diamonds or water?” consumers are likely to answer diamonds. This, however, is very different from the question: “Would you rather have a diamond or an extra 100 gallons of water a week?” to which the answer will probably be a diamond. The first question relates to the total value while the second relates to the marginal value. The value of one extra unit of water is low compared to that of diamonds, but the consumer surplus associated with water is huge.