# 3 Welfare measures in the market

As we mentioned before, in microeconomics, we call *market* the "conceptual" place where buyers and sellers trade in **one good**. We have obtained a summary of how buyers (consumers) behave in that conceptual space: as they choose what bundle to buy with their income, they decide, in particular, how much of each of the goods to buy: their demand function for each of the goods (given prices of other goods and income profiles of consumers). Also as we have mentioned, we (may) represent the mapping from prices to quantities of a good that one (individual) consumer, consumer $i$, acquires as $D^i(p)$, ignoring for now the (given) income and other prices. For instance, that mapping may be:

| $q$ | $p$ |
|---|---|
| 1 | 16 |
| 2 | 12 |
| 3 | 9 |
| 4 | 7 |
| 5 | 5 |
| 6 | 4 |
| 7 | 2 |

Table 3

If we read from right to left, we observe that at price 16 the consumer (given her income and the prices of other goods) buys 1 unit of the good. At price 12 she buys 2 units, etc. Now, look at that table again and try to understand what the mapping from left to right represents. That is, what sort of mapping is the one that assigns to quantity 3 the price 9. (Yes, the inverse of the demand function.) Of course, the answer is simple: for the consumer to demand 3 units, the price should be (no more than) \$9.

Note that we can read the table in any direction we want, and we are still reading the same information (which, remember, is the result of the consumer solving problem (5)). If we read from right to left we have the information ($q =$) $D^i(p)$, as we have mentioned –e.g., $3 = D^i(9)$, $6 = D^i(4)$, etc.–. If we read from left to right we have the inverse of that function, ($p =$) $P(q)$, the **inverse demand function** –e.g., $7 = P(4)$, $16 = P(1)$, etc.–.

Once you understand how to read the inverse demand function, consider the following question: what does it mean that the consumer buys 4 units if the price is 7 but would only buy 3 units if the price was slightly higher than 7, as Table 3 informs us? You would probably agree that it means that the consumer is **willing to pay** (up to) \$7 for an extra unit of the good **when** she already has 3 units. That is, she is willing to pay \$7 for her **fourth** unit. If so, you probably agree that the (or rather, one) way of reading $P(4) = 7$ is: the consumer **values** a fourth unit of the good at \$7.

So (given her tastes, circumstances, other prices, etc.) we can also say things like: consumption of, say, 3 units has a value of $16 + 12 + 9 = 37$ dollars for this consumer: she values her first unit at \$16, then a second unit at \$12, and then a third unit at \$7. If we agree on this, we have just built ourselves a dollar measure of the value that this consumer assigns to different quantities of consumption. (Given everything else, in particular, things that happen in other markets,) The consumer obtains a value that we can put at \$37 from consuming 3 units, would obtain \$7 **extra** value from consuming a fourth, which would put the value of consuming four units at \$44, etc. That *value* we call **gross consumer surplus**. That is, simply the sum of her **willingness to pay** for each extra unit, from the first to the $q^{th}$.

Again, notice that this information comes from our model of consumer behavior. That is, from the solution to problem (5). It is important that you follow the connection, the "story" we are telling.

Consumers typically need to pay money to obtain the goods they consume, as we have been assuming. For instance, imagine that the price of the good that Table 3 refers to was \$6. In that case, we see that this particular consumer would buy 4 units (make sure you agree with this). Thus, she would pay \$24 for the her consumption of that good. Therefore, she would be paying \$24 for something that, as we have discussed, she values at \$44. The difference (thus, the difference between gross consumer surplus and payments) is a surplus that the consumer obtains by participating in the market. We call this surplus **consumer surplus**. (That is, simply the gross consumer surplus **net** of her payments for the good.)

Note two things: a) this is a measure in dollars, and so it can be compared or added to other dollar measures, for instance, other consumers' surplus, profits, etc.; b) this is a measure of the value that a consumer obtains for being able to trade in the market of that particular good. If we now shut down that market, the consumer loses something that she values at \$24, in this example!

We have defined these concepts with an example of indivisible goods. What if the good is divisible? (We have talked about the first, second, third units, but how about the first half of the unit, etc.?) The answer is that nothing really changes. Indeed, we may now talk in terms of "a tiny extra bit" of the good. For instance, if the inverse demand function for the consumer is $P(q) = 10 - 2q$ (which means that her demand function is $D(p) = 5 - \frac{1}{2}p$, right?), then we may say that the consumer's willingness to pay (per unit) of a little extra quantity of the good when she is consuming $q = 3$ units is $10 - 2 \times 3 = \$4$. Or that the willingness to pay (per unit) when she is consuming 3.2 units is $10 - 2 \times 3.2 = \$3.6$. In general, the per unit willingness to pay for a little extra quantity (which we may say, for short, the willingness to pay for one more unit) when she is consuming $q$ units is $P(q)$. Thus, the inverse demand function still measures, as in the indivisible case, the consumer's (per unit) willingness to pay for some extra (tiny) quantity when she is consuming $q$ units.

Thus, the gross consumer surplus for a consumer that consumes $q$ units is the **area** below the inverse demand function between 0 and $q$! And the consumer surplus, if she pays $p$ dollars per unit, is simply that area minus $p \times q$ dollars.

We have represented in Figure 21 the consumer surplus. Note that the vertical axis (price) is a measure of dollars per unit, and the horizontal is a measure of units. Thus, any area there has measure in "$ per unit times units", i.e., dollars. So, yes, the size of the shaded area (in particular) is a measure of dollars. Also, note that the distance between the inverse demand and the price is the difference between willingness to pay and payment (per unit), and so it measures the (per unit) surplus appropriated by the consumer for that tiny bit of good. You add across all the (tiny bits of) units that the consumer consumes, and you get indeed the consumer surplus when she consumes $q$ units.

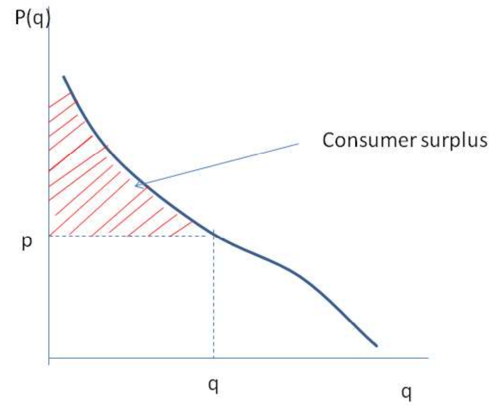


Figure 21

In exercises, we will use linear demand functions, so that the shape of that area will be a triangle (and you do not need to know how to *integrate* the inverse demand function in order to compute it). But consumer surplus (or CS) **is not a triangle**! It is, once more, the difference between how much the consumer values the units she consumes and how much she pays for them. (Please, don't construct a triangle of some sort when computing the CS for a consumer whose inverse demand function for a non divisible good is given by a table like Table3!)

## 3.1 The change in consumer surplus when the price changes

Once more, note that the **welfare measure** that we are using, consumer surplus (and profits, when we talk about firms) refers to value created in **one** market, and so we are disregarding the fact that changes in this market may affect the behavior of the consumer in other markets. In particular, it may affect how much she is willing to pay in those other markets (her inverse demand function in those markets, and so her surplus there).

Keeping that in mind, we will still ignore these other (indirect) effects of a change in the price in one market. The effect on the consumer surplus in the market for the good whose price changes is a good first approximation to the total effects if the change in the price has small effects on the consumer's choices in other markets. For instance, if the consumer spends a small proportion of her income in the good we are considering.

With this caveat, let us analyze the effect of, for instance, an increase in the price of the good on the consumer surplus (in that market). Suppose that we are looking at the consumer whose demand is represented in Table 3, and also suppose that the price of that good is originally \$4. You can see that the consumer would then buy 6 units, and that her consumer surplus would be \$29. Now suppose that the price increases to \$7, so that the consumer would reduce the quantity demanded to 4 units. Her consumer surplus would then be \$16, and so the increase in price implies a reduction in her consumer surplus of \$13.

However, I would like to call your attention to the two different sources of this reduction in surplus. First, after the increase, the 4 units that the consumer still buys each costs the consumer \$3 more. That is, the consumer loses \$12 from the higher cost of those units that she still buys. Second, the consumer buys two units less. Those two units gave her the extra \$1 (the willingness to pay for the fifth unit minus the original price) that the consumer loses.

Why separating the effect into these two parts? Consider answering the question from the society point of view. The first effect simply means that the consumer pays \$12 extra dollars **to someone else** (the seller). That is the only effect for society. Those four units are still (produced and) consumed, but the 12 dollars changed hands. *Society* has not lost them. However, the second implies a real change beyond dollars changing hands (transfers). Indeed, the fourth and the fifth units are not consumed (or produced). Thus, beyond changes in "virtual" accounts (money, bank balances,...), that extra dollar represents a material change.

We will come back to this point when we discuss efficiency and complete our discussion of (partial equilibrium) welfare. Now, let us consider the same exercise when the good is divisible. The two effects that we have discussed are represented in Figure 22 for such case.

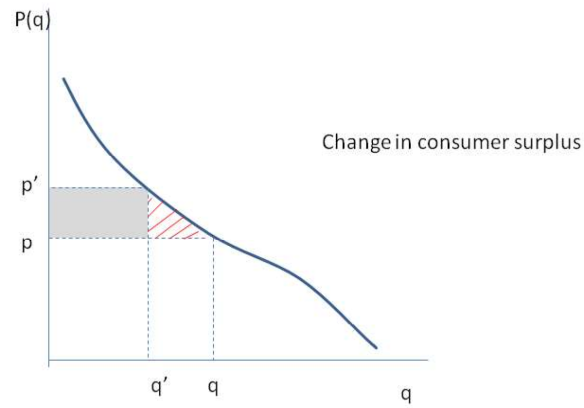


Figure 22

As the price increases from $p$ to $p'$, the consumer reduces demand from $q$ to $q'$. The first effect on her consumer surplus is a reduction equal to the size of the gray-shaded area, $(p'-p)q'$, due to the fact that what she still buys is more expensive than it used to be. The second effect is a reduction equal to the size of the red-shaded area, due to the lost consumer surplus on the units that she does not buy anymore. (The size of this second are is $\int_{q'}^{q}(P(x)-p)dx$. When the demand function is linear –the curve is a straight line–, that area is triangular and you can compute its size using your knowledge of geometry.) Again, this second effect captures a change in the volume of trade in the market, beyond the simple exchange of dollars.