Lecture Note 6, Part 1: Applying Consumer Theory to Competitive Markets – The United States Sugar Program

David Autor, MIT Economics and NBER

14.03/14.003 Applied Microeconomics and Public Policy, Fall 2022
Updated 10/10/2022

1 Applying Consumer Theory to Competitive Markets

When exchange takes place voluntarily among economic agents (consumers, producers), theory suggests that all market participants benefit. Were this not the case, participants presumably would not have voluntarily engaged in the exchange. (Very soon we'll discuss why this may not always be true. The distinction has to do with individual level voluntary exchange versus market-level movements in price and quantities.) It's useful to have a dollar metric of the gains from transacting, similar to how we developed a dollar metric of how price changes affected consumers in previous lectures. This measure is economic surplus—the sum of consumer and producer surplus—in dollar terms. The notions of consumer and producer surplus are critically important. Although we can readily measure the direct costs of a given project or policy (i.e., building a bridge, imposing a tariff), costs are not necessarily equal to benefits. Demand and supply curves allow us to measure these benefits. When costs exceed benefits, we call that deadweight loss. When benefits exceed costs, we call that surplus: consumer surplus, producer surplus, or more generally 'social surplus,' which does not distinguish between consumers versus producers.

As we discussed in the first lecture, we can think of the market demand curve as the set of consumers arrayed in inverse order from the person with the highest Willingness to Pay (WTP) to the person with the lowest WTP for a good. Similarly, we think of the market supply curve as the set of producers arrayed in order from firm willing to produce a good at the lowest price to the firm demanding the highest price to produce the same good. (This is sometimes called Willingness to Accept or WTA.)

Consumer surplus is the difference between the maximum value that a consumer is willing to pay for a good and the market price of that good. In market equilibrium, the marginal consumer of a good gets no surplus from the purchase (he or she is indifferent) whereas the inframarginal consumers receive positive surplus. Analogous to consumer surplus, the relevant measure of surplus for firms (producers) is producer surplus. This is the area above the supply curve, equal to what the producer receives for goods in excess of the cost of production.

In an ideal world, the market matches consumers and producers. If in equilibrium a producer is willing to produce at a price less than or equal what a consumer is willing to pay, we expect that transaction to occur. Most consumers will be buying at a price *below* their maximal willingness to pay, and most producers will be selling at a price *above* their lowest willingness to produce. Surplus accrues up to the point at which the marginal producer and consumer are indifferent between selling/buying and going home. When this mechanism works in its canonical textbook form, it maximizes the sum of producer and consumer surplus—meaning that all gains from trade are realized, all transactions that benefit both parties occur, and no transactions occur that do not benefit both parties. (These statements are equivalent.)

Notice that this metric does not place any greater weight on consumer versus producer surplus. If the supply of the good in question is perfectly elastic, all of the surplus is captured by consumers. If demand is perfectly elastic, all of the surplus is captured by producers. This metric also places the same weight on each individual consumer and on each individual producer (no producer or consumer's surplus is valued as 'more important.') Why do we want to maximize surplus without regard for the identities of the beneficiaries? Don't we care about *both* equity *and* efficiency? As we'll discuss soon in the section on General Equilibrium, the goals of maximizing the pie and redistributing the pie are *not* in tension in a *fully competitive market* (we'll define that term too!). In other words, there is no intrinsic tradeoff between maximizing the pie and determining the size and allocation of the slices. This lecture focuses on the first goal: maximizing the pie. We will address the second soon.

In the analysis that follows, please keep the following three points in mind:

1. All costs are opportunity costs.

    - In economic reasoning, *intrinsic value* is not a well defined term. Absent other arguments, the economic cost of using a given resource is the value of its alternative to which it could have been put. This is its *opportunity cost.*
    - Why is gasoline so comparatively cheap (less per gallon than mouthwash or shampoo) when it is an indispensable commodity for most U.S. households. (Which would you rather live without, mouthwash or gasoline?) The simple answer is that gasoline is relatively abundant, so the last gallon isn't worth much—its opportunity cost is low. The high value uses of gasoline (fueling fire trucks, ambulances, and NASCAR vehicles) will surely be satisfied even at high prices. It's only when gas gets cheap that people start taking day-long jet-ski excursions, cranking up their gas-powered beer coolers, and entertaining the kids with their Home Flame Throwers. Conversely, when gas is scarce, prices rise substantially since the first gallon is very valuable indeed—it might mean life or death to someone whose house is on fire or who needs to urgently get to a hospital. The equilibrium price of a gallon of gasoline is determined by the opportunity cost of the marginal gallon, not by the value that people place on the first gallon (or the inframarginal gallons between first and last). This observation—that prices reflect scarcity rather than intrinsic value—is often referred to the diamond-water paradox. I prefer to call it the gasoline-mouthwash paradox.

2. A *transfer* between two agents is not necessarily a net social gain or loss

    - If I someone pays me \$5 to perform a task, that is *not* a \$5 social gain even though the person hiring me has 'generated a job.' Why? This transaction is, to a first approximation, a transfer of \$5 from one person to another—although a new task was also completed thanks to the transaction.
    - *If* there is a gain, it is because the value that I produce is worth more than \$5 to the person hiring me (i.e., consumer surplus) and/or my alternative use of time is worth less than \$5 to me (i.e., producer surplus). The hourly wage that a worker earns at her job is not a measure of her surplus because (a) her time has an opportunity cost—there are other valuable things she would like to be doing if she were not working; (b) work may require effort that has direct disutility (physical exertion, intellectual boredom, mental exhaustion, etc.). Thus, the social surplus could be considerably smaller than the amount of money changing hands (and should be zero at the margin).

3. An important corollary to this point: *a cost is not a benefit.*

    - If we raise the wages of all federal employees in the United States by 10%, what is the *net social benefit* of this wage increase? A good first approximation is *zero.* This is simply a transfer from one group of citizens (taxpayers) to another (federal employees). (In addition, because taxation distorts prices, there will generally be a small deadweight loss associated with the tax increase—meaning that the net social gain could be negative.)
    - As an aside, note that Gross Domestic Product (GDP) is roughly equal to the amount of money that changes hands in transactions nationwide in a given year.[1] So if you and I mow each others' lawns rather than mowing our own lawns, we've added to GDP, even though no more work is done than if we each mowed our own lawns. Thus, when reading the newspaper, remember that GDP roughly captures the business of an economy but does *not* correspond in any direct or meaningful way to the social surplus produced by an economy.

[1] Formerly, it's equal to Personal Consumption Expenditures plus Business Investment plus Government Spending plus eXports minus iMports: $C + I + G + X - M$.

2 Measuring Consumer and Producer Surplus Using Demand and Supply Curves

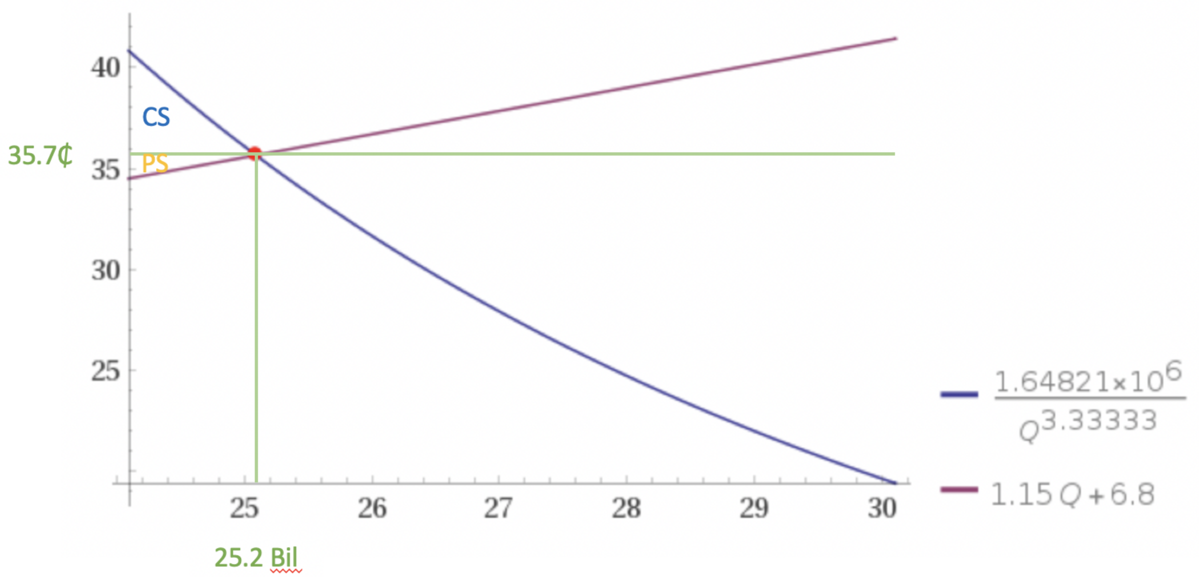
Recall from the very first 14.03/003 lecture that we defined the supply curve as the sellers of a given product or service (include labor supply) arrayed from *lowest to highest* reservation price (wage). Thus, integrating under the supply curve provides a measure of the *cost* of supplying that product or service. If each seller is paid only his or reservation wage/price, there is zero surplus to the seller. Similarly, the demand curve corresponds to all of the given buyers of a product or service (e.g., employers) arrayed from *highest to lowest* willingness to pay. If each buyer pays exactly his or her reservation price, there is no surplus to the buyer. Surplus from a transaction arises when the willingness to pay of buyers exceeds the reservation price of sellers. In a well functioning competitive market, the marginal buyer and seller of a product are *indifferent* about transacting, since each is receiving exactly his reservation value, while all other transacting parties are receiving some positive amount of surplus.

To formalize, let's say that we can describe the Demand and Supply of sugar (in billions of pounds) using the following schedules:

$$D(p) = 73.3p^{-0.30}$$

$$S(p) = \frac{(p - 6.8)}{1.15},$$

where p is the market price (in cents). We can solve for the equilibrium price in this market. It's slightly hairy, but the answer is $p^* = 35.7$c, where "c" is the abbreviation for cents. [Consistency check: $D(p = 35.7\text{c}) = 25.2$, $S(p = 35.7\text{c}) = 25.2$, so this is a market clearing solution.]



Note that to plot these demand and supply curves, I inverted these functions (p as a f'n of Q rather than Q as a f'n of p).

$$p_d(Q) = \left(\frac{73.3}{Q}\right)^{\frac{1}{0.3}}$$
$$p_s(Q) = 6.8 + 1.15Q$$

What is producer (seller) surplus in this market? (Note: PS equals sale price minus cost.)

$$PS = 35.7 \times 25.2 - \int_0^{25.2} (6.8 + 1.15q)dq = 900 - 537 = 363.$$

What is the consumer (buyer) surplus in this market?[2] (Note: CS = WTP minus purchase price)

$$CS = \int_1^{25.2} \left(\frac{73.3}{q}\right)^{\frac{1}{0.3}} dq - 35.7 \times 25.2 = 705,997 - 900 = 705,097$$

While the specifics parameters and functional forms are not important, this example underscores that supply and demand curves provide the basic tools for performing applied competitive analysis for a single market (e.g., the market for sugar).

[2]Note that this functional form gives almost infinite marginal value to the first unit of consumption, so if we integrate from 0, the function does not converge. This is a bug, not a feature.

3 The U.S. Sugar Program

As detailed in the readings, the U.S. Sugar Program is a system of import quotas administered by the U.S. Department of Agriculture that is designed to reduce the supply of imported sugar to the U.S. market with the goal of achieving a target domestic sugar price. Our class objective in this exercise is to estimate the economic costs and benefits of this quota policy—that is, what are the gains to consumers and producers and the efficiency costs (deadweight losses), if present.

3.1 Analytics

We will use basic competitive theory to analyze the economic consequences of the U.S. sugar program. Working from a competitive baseline scenario of what the price and quantity of sugar sold in the U.S. market would be *absent* the Sugar Program, we can decompose the deviations from this baseline into three components:

1. *Transfers between consumers and producers.* Externally imposed changes in quantities or prices will generally induce some transfer of surplus from consumers to producers or vice versa. These transfers are *not* efficiency losses (though one may still view them as unwarranted windfalls to specific groups).

2. *Deadweight losses from foregone consumption.* A price or quantity quota will generally reduce equilibrium consumption below its competitive level. This implies that there are foregone units of the good that producers would have been willing to produce at a price that consumers would have been willing to pay, if not for the quota. These thwarted transactions are therefore a deadweight loss, reflecting losses of consumer *and* producer surplus.

3. *Deadweight losses from inefficient resource allocation.* Price or quantity restrictions may also cause production distortions. If these restrictions artificially boost prices, high cost and inefficient producers that would not be viable in a competitive market may find it profitable to operate. In these cases, there is the usual loss in consumer surplus and/or producer surplus *and* an additional deadweight loss incurred: real resources are consumed by high-cost producers to produce goods that low-cost producers could have made absent the distortion.

To implement this analysis, we need to estimate the consumer demand curve (to assess consumer surplus) and the producer supply curve (to assess producer surplus). With these in hand, we can consider the consequences of the quota system relative to a counterfactual case in which the market is competitive.

So far we've studied consumer surplus at the level of *individual consumers* using individual demand curves stemming from utility maximization. To operationalize the notion of surplus at the *market* level, we need measures of producer costs and consumers' willingness to pay—that is, we need information on the market supply and demand curves. In point of fact, we often have pretty good data on producers' costs, which should reflect their willingness to produce at various prices (that is, their Willingness to Accept or WTA). It's much harder to measure consumer's Willingness to Pay (WTP), since this is a function of consumer preferences (i.e., utility) rather than observable production costs among producers. When it's tough to estimate a whole demand curve, we often estimate the elasticity of consumer demand for a commodity and extrapolate what a reasonable demand curve would look like. Specifically, if we know both a price-quantity pair on the demand curve and the elasticity of demand (that is, the slope of the demand curve), we can estimate the area under a standard demand curve to calculate measures of surplus (WTP minus price).

For our analysis of the U.S. Sugar Program, we'll use the uncompensated (Marshallian) demand curve for sugar. Why not the compensated demand curve? Two reasons. First, it's not really feasible to estimate a compensated demand curve at the market level—what would it mean to hold "market utility" constant? In addition, recall from the Slutsky equation that $\partial d_x/\partial p_x = \partial h_x/\partial p_x - (\partial d_x/\partial I)\, X$. This equation says that the compensated and uncompensated demand curves don't differ by much if $(\partial d_x/\partial I) \cdot X$ is small. This will be true if the income effect is small *or* if the commodity in question (here sugar) is a small share of consumer budgets—so, there is very little change in consumers' real income when sugar prices change. The latter condition is quite likely to be true.

According to the United States Department of Agriculture's Economic Research Service, U.S. sweetener deliveries (including both sugar and High Fructose Corn Syrup or HFCS) in 2017 were 127.1 pounds per capita. At the historically high U.S. market price of sugar – \$0.64 per pound in 2016 – sugar expenditures would amount to only \$81 per capita. (Though frankly, that's still an amazing amount of sugar; Americans are basically eating their weight in sugar annually.[3]) Thus, even substantial fluctuations in the price of sugar (a doubling or halving of the price, for example) would have minimal effects on consumers' household budgets, and so the difference between compensated and uncompensated demand will be small in this setting. (The compensated/uncompensated distinction matters quite a bit in some settings, but not in our example.)

[3] See Table 50 at USDA.

Details to follow in Part 2 of this lecture note...